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MATERIALS SCIENCE AND METALLURGY

No. 89

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USSR REPORT

MATERIALS SCIENCE AND METALLURGY

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UDC 669.715:620.1

ALUMINUM-SCANDIUM ALLOY PROSPECTS

Moscow TSVETNYYE METALLY in Russian No 12, Dec 82, pp 96-99

YELAGIN, V. I., ZAKHAROV, V. V. and ROSTOVA, T. D.

[Abstract] Addition of some tenths of 1% scandium to aluminum and its alloys greatly influences their structure and properties similarly to the influence of other group four transition metals, but more strongly. Alloys of aluminum with 0.3 to 0.4% scandium show a great increase in recrystallization temperature (150 to 250°C). The addition of scandium prevents embrittlement of Amg2 aluminum alloy upon long-term exposure to high temperatures and neutron bombardment. Electron microscope studies of thin foils showed that decomposition of a scandium solid solution in aluminum results in precipitation of stable Al_3Sc phase particles. Scandium alloying increases the strength and in some cases ductility as well as corrosion cracking resistance and weldability of aluminum alloys. Figures 4; references 8: all Russian.
[58-6508]

WEAR-RESISTANT COATINGS DISCUSSED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 18 Jan 83 p 2

[Article by Professor S. Maslenkov, doctor of technical sciences, deputy director, Institute of Metallurgy, USSR Academy of Sciences: "Initiative Without Yield"]

[Text] Today's huge requirement for agricultural equipment is dictated in no small degree by the inadequately high reliability of many machines. For example, for some grain combines the duration of the operating period until the first breakage or failure is only 7-14 hours. Among the causes of these failures we frequently hear the quality of the metal, which is not always good enough for those rigorous conditions under which agricultural equipment is operated. Its assemblies and parts are subjected to impact and vibrational loads, abrasive wear when soil falls into mechanisms, and severe corrosion in liquid, viscous and other aggressive mediums.

Until recently it was thought that frequently only high-alloy steels can resist such effects for a long time. However, research and development work done in recent years showed that most parts of agricultural equipment can be made of cheap carbon and low-alloy steels that successfully provide the required structural strength. In order to increase their reliability and durability, it is sufficient to apply the appropriate coatings to their working surfaces. This can be done by spraying powdered materials with the help of plasma, surfacing methods and other already well-developed methods.

In many cases, the needed properties are produced by powders made from oxides and ferroalloys. Also effective are intermetallide coatings, which are composed of aluminum, nickel and titanium: they combine high thermal and corrosion resistance with good adhesion to the surface of unalloyed steels. The number of prospective materials also includes carbides and cermets, which are a unique type of "hybrids" of ceramics and metal. Coatings based on graphite or molybdenum disulfide enable rubbing parts to function without a lubricant.

The effectiveness of such technology can be judged by the following example: wear-resistant coatings of intermetallide and carbide powders, applied by the plasma spraying method, increase the service life of materials by a factor of 3-15. The cost of this operation usually does not exceed 10 percent of the part's cost. As a result, the use of a single ton of powders saves, on the average, up to 40-50 tons of steel, cast iron and nonferrous metals and produces an economic effect on the order of 100,000 rubles. And this says nothing about the savings in labor and the reduction of energy consumption.

The problem of protecting the steel parts of agricultural and livestock equipment from corrosion is solved analogously. In order to do this on a broad scale it is possible to use arc plating with aluminum wire or plasma spraying of various powders. For the aluminum coating that is produced, resistance to atmospheric corrosion is better than than of paint and varnish coatings by a factor of about 5-10. If it is additionally impregnated with polymers or paints the service life of parts can be extended to 25-50 years.

All of these advantages of resistant coatings were among the first evaluated by specialists from Goskomsel'khoztekhnika [possibly State Committee for Agricultural Equipment]. It is easy to explain their interest: today, expenditures for the maintenance of equipment in working condition amount to almost one-fifth of its balance cost. About 60 percent of parts have to be replaced simply because of the fact that their working surfaces are worn down by 0.3 mm. The restoration of this wear by the application of powdered coatings represents no special difficulty. And the gain is obvious: there is a sharp reduction in the consumption of spare parts, metal is saved, labor expenses are reduced and agricultural equipment and automatic machinery suffer less down time.

In order to realize these advantages, the USSR State Committee for Science and Technology, the USSR Academy of Sciences and USSR Goskomsel'khoztekhnika adopted a joint resolution on the organization of the first 12 regional centers for the introduction of progressive technology. There is no doubt of the importance of this step. At the same time, however, we should recognize that it is directed only at "curing the illness." However, as is known, it is much better to prevent it. It is completely clear that separate parts that have been "cured" at Goskomsel'khoztekhnika's enterprises only partially affect the reliability of machines. In order to improve it radically, the appropriate coatings must be applied to parts during the agricultural equipment manufacturing process. However, the machine builders are still not hurrying to make use of this possibility.

To specialists who are familiar with the essence of the problem, this attitude can seem, at the very least, strange. All the more, since Minister of Tractor and Agricultural Machine Building A. Yezhevskiy, when he was chairman of Gozkomsel'khoztekhnika, was himself the initiator of the widespread introduction of coating technology. His interest in it is shared by many leading workers in his ministry. However, this interest weakens rapidly as the matter moves from top to bottom, to the shops of enterprises. For example, in accordance with the assignments of the State Plan for 1982, Minsel'khozmash [Ministry of Tractor and Agricultural Machine Building] were to have produced 68,000 parts with gas-thermal coatings. However, they underfulfilled their quota by one-third. The ministry also lags behind in the development of capacities for the application of such coatings by about 30 percent. Moreover, even the available foreign-purchased installations for the application of coatings frequently stand idle. References to the lack of imported powder can hardly be considered well founded, since it can be replaced successfully with Soviet-made powder produced in Tula. This means that the real reasons should be sought elsewhere.

From the viewpoint of production workers, the application of wear-resistant coatings to parts is an additional, "excess" operation that is reflected threateningly in the enterprise's indicators. Certain expenditures are also required in order to equip the production facility with the installations for applying the coatings by

mechanized and automated means. Who pays them? The existing system of economic stimuli does not offer much incentive for efforts to improve the reliability of individual machinery assemblies and units. An improvement in their overall characteristics, so as to increase their value, cannot be achieved immediately: in the initial stage there are not enough installations to apply coatings to all the vulnerable parts.

All of these misgivings are not groundless. Even here, however, there is a rational solution. Starting with the capabilities of the available equipment, it is possible to select the parts that fail most rapidly and make them the ones to be "dressed" with a coating during the first stage. Then, as the technological capabilities grow, the most "vulnerable" of the remaining parts should be included in the ones being treated. The incentive system should also be aimed at just such a stage-by-stage improvement in the reliability of the machines produced by an enterprise. Who will do this? One would think that the initiative should come from the machine builders themselves. The USSR State Committee for Science and Technology is obligated to support this undertaking.

We should now take a look at yet another problem involving both metallurgy and the Food Program. This is the utilization of phosphorus-rich slags from the smelting of steel.

There is no need to prove that they can replace superphosphates in high-quality fertilizers: for many years the "Azovstal'" plant has been delivering annually up to 400,000 tons of such slag, containing 10-12 percent phosphorus pentoxide, to farms in the Ukraine. Also well known is the experience of the Western European countries, where the use of metallurgical slag in agriculture is practically commensurate with the production of superphosphate. Moreover, in some of these countries the slag is imported.

In our country, "Azovstal'" is not the only producer of phosphate slags. The Karaganda Metallurgical Combine produces almost twice as much--about 0.8 million tons--every year. Research done by scientists at the Academy of Sciences of Kazakhstan showed that in comparison with superphosphate, fertilizers made with slag will cost half as much, will make it possible to stop liming the soil, and in some areas will make it possible to obtain higher grain crop yields. However, right now these slags are still being wasted completely.

In the future these tailings will become even larger: when the Lisakovsk Ore Enrichment Combine reaches its planned capacity, its ore processing operations will be accompanied by the appearance of 1.9 million tons of phosphate slag per year, and this slag will contain up to 17 percent phosphorus pentoxide. If used for fertilizer it could fill the needs not only of all of Kazakhstan, but also of many farms in the area of the Baykal-Amur Main Line. However, the problem of using this wealth has gotten hung up on departmental boundaries.

Specialists at Minchermet [Ministry of Ferrous Metallurgy] state, quite naturally, that the production of fertilizer is not their job. The leaders of "Soyuzsel'khozkhimiya" [expansion unknown] have their own opinion: they think that the use of the Karaganda phosphate slags is a regional problem that should be solved by forces in the republic. And specialists at the Ministry of Mineral Fertilizer Production, for which the problem of phosphorus raw material is one of the most

acute ones, are ignoring tailings on the basis that they are not deposits but the by-products of metallurgy. This is even though the amount of phosphorus in such by-products is greater than in the depths of the Kola Peninsula.

The USSR State Committee for Science and Technology has attempted to move this matter from dead center by creating an expert commission. It is obvious that one of its suggestions will be to include phosphate slags in the list of phosphorus raw material reserves. However, this measure is only the prerequisite for the solution of the problem. The solution itself can be put off for an indefinite period.

In our opinion, it is time for USSR Gosplan to intervene and redistribute the capital investments for fertilizer production so that Minchermet gets a share. The excuses of specialists in the ministry should hardly be taken into consideration: the processing of slag into fertilizer does not hinder "Azovstal'" in carrying out its basic assignments. As a matter of fact, the processing is not even very complicated: the slag only has to be pulverized, packed up and sent to the user. Such a shop was planned for the "Gipromez" Metallurgical Combine in Karaganda as long ago as 1970. However, it will be built quickly only with the active assistance and support of the party and economic agencies in Kazakhstan.

The time factor, first of all, speaks in favor of such a solution: the processing of slag can be organized much more rapidly than the building of new capacities for the production of superphosphate. Thereby will be created the conditions for the approach, the importance of which was emphasized at the November (1982) Plenum of the CPSU Central Committee: the vast means directed at the Food Program must yield a return right now.

11746
CSO: 1842/71

ION PLASMA DIFFUSION COATING APPLICATION BOUNDARY CONDITIONS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 11 May 81) pp 24-27

YUKHIMCHUK, S. A., Zaporozh'e

[Abstract] Experiments show the possibility of producing diffusion coatings using a discharge at temperatures below the recrystallization temperature of the materials being worked. The process of ion-plasma diffusion application can be divided into the following stages: 1) ionization of the admixtures; 2) drift of the ions formed to the surface; 3) electro-mass transfer at the metal-plasma boundary; 4) movement of the impurity ions within the material being worked. In experiments involving carburation of iron the electric field intensity in the metal was $3.7\text{-}11.9 \cdot 10^{-6}$ V/m, effective carbon charge +9.5. These values indicate an increase in the probability of transition of the impurity into the interstices of the lattice by a factor of 7 to 11. This example of carburation plus chrome plating serves to support the working hypothesis of the mechanisms of transfer. Figures 3; references 6: all Russian. [82-6508]

ELECTRON MICROSCOPE STUDIES OF COATINGS IN MAGNETOELECTRIC HARDENING

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 24 Nov 81) pp 28-30

KAS'KOVA, E. G., MARKUS, E. Ya., ROZIN, M. M., Kemerovo

[Abstract] An attempt is made to supplement available data from metallographic structural analysis and to study the phase composition of layers by micro-diffraction of extraction replicas and the dispersion of segregated particles. Studies were performed on a metallographic microscope and electron microscope using carbon replicas shadowed with chromium at 40°c. Replicas were separated mechanically with a 15 to 20% aqueous gelatin solution. The structure of the five specimens produced is described. References 11: all Russian. [82-6508]

UDC 678.5.06:539.4.014

STATIC STUDY OF MECHANICAL CHARACTERISTICS OF POLYMERS AND COMPOSITES

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 82 (manuscript received 8 Oct 81) pp 68-73

GOL'DMAN, A. Ya., MATVEYEV, V. V. and ZARAPINA, V. F., "Plastpolimer" Scientific-Production Union, Okhtinsk, Leningrad

[Abstract] An attempt is made to determine the influence of polymer type on the distribution of various mechanical characteristics. Four groups of polymer materials were statistically studied: 1) ABS+PVC composites; 2) UPS+UPM dispersely filled composites; 3) polystyrene; 4) high density polyethylene. Standard samples were analyzed by computer to produce the distributions and characteristics. The Υ, normal and log-normal distributions yielded approximately the same results. The Laplace-scharlier four-parameter distribution, considering asymmetry and excess, yielded the best fit. Figures 4; references 5: all Russian.
[55-6508]

UDC 621.315.56:666.98:539.219.1

PERCOLATION ELECTRIC CONDUCTIVITY OF THREE-PHASE COMPOSITE MATERIALS

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR. SERIYA TEKHNICHESKIKH NAUK in Russian, No 13, Issue 3, Oct 82 (manuscript received 22 Jul 81) pp 87-89

DOBZHINSKIY, M. S., KATS, Ye. L. and REPYAKH, L. N., Siberian Scientific Research Institute of Power Engineering, Novosibirsk

[Abstract] The authors use flow theory to investigate three-phase composite materials, using five samples of electrical engineering concrete to test their conclusions. This concrete is composed of finely dispersed carbon powder (soot in one sample, furnace coke in the others) as a conductor, portland cement as a binder and sand as a filler. When wet, this mixture forms three phases: carbon particles; a gel, dielectric particles and pores that are

smaller than and comparable in size to the conductor particles; large dielectric particles and pores. The first two of these form a continuous structure, and the authors find that the entire system's electric conductivity increases significantly when the concentration of carbon equals the flow threshold value. Figures 2; references 7: all Russian.
[70-11746]

UDC 621.762.4.001

PROCESSING SOLID LUBRICANT COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 82 (manuscript received 20 Nov 81) pp 9-11

SYRVACHEVA, T. A., LOBOVA, T. A., LIBENSON, G. A. and TARLAVSKIY, V. E., Moscow Institute of Steels and Alloys

[Abstract] Self-lubricating refractory metal dichalcogenide-based composites are produced by mixing components, pressing and sintering. The compactability of WSe_2-Ga/In composite materials was compared with that of copper powder in a steel press mold 9 mm in diameter on an instron machine. The studies revealed that the WSe_2 based materials are pressed better in the first stage than highly plastic copper powder, a result of the low coefficient of friction between particles and easy fracture and slippage of particles. Maximum compacting is achieved in the first stage of pressing, after which the interparticle contact areas practically do not increase. Figures 2; references 7: 6 Russian, 1 Western.
[59-6508]

UDC 621.791.76

PLASTIC DEFORMATION OF MULTILAYER COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 82 (manuscript received 13 Oct 81) pp 47-50

NORONOV, S. V. and DEVOYNO, D. G., Belorussian Polytechnical Institute

[Abstract] A study was made of the influence of plastic deformation on the bond strength of layers and shape accuracy of multilayer composites obtained by high speed collision. Experiments on rolling of multilayer blanks were performed on a duo mill with roll diameter 200 mm, operating speed 30 rpm. The influence of plastic deformation on joint strength was determined in an aluminum-copper bimetal with clearly nonoptimal collison parameters and resulting weak bond strength. Plastic deformation significantly increased the joint strength for substances such as this which produce brittle intermetallic compounds when explosively clad. Variation in the speed of the rolls can be used to obtain straight bimetallic strips by selecting the degree of compression of the two materials. Figures 3; references 4: all Russian.
[59-6508]

UDC 541.12.017:669.018.44:539.376.001

SIMULATION OF CREEP AND FRACTURE IN DIRECTIONALLY CRYSTALLIZED GAMMA/GAMMA'-MeC EUTECTIC

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 55, No 1, Jan 83 (manuscript received 1 Jun 81, after final editing 27 May 82) pp 171-177

KISHKIN, S. T., SVETLOV, I. L., OVCHINSKIY, A. S., ABALAKIN, N. P., GOLUBOVSKIY, Ye. R. and GUSEV, Yu. S., All-Union Scientific Research Institute of Aviation Materials, Moscow

[Abstract] A eutectic composite material is considered, its matrix ZhS6 elastoplastic heat-resistant cast nickel alloy and its reinforcement consisting of continuous oriented filiform crystals in a volume fraction far below critical. Creep and fracture in such a material, following application of a load, are analyzed by the method of mathematical simulation. The creep rate is described by the equation of state in the form of an inverse-power and exponential temperature-force relation, with seven parameters to be evaluated through statistical processing of experimental data. The initial strain level is determined on the premise that both components of the material deform elastically at the instant of load application. According to the additivity rule, which is held valid here, an increment of strain in the reinforcement produces a proportional increment of stress in it and a corresponding decrement of stress in the matrix. The analytical expression for the defectiveness buildup is based on a Weybull distribution of initial strength. The system of equations is closed by conditions of compatibility in terms of strains and strain rates. The process of stress redistribution between matrix and reinforcement in the composite has been calculated for an SOTAS-744 eutectic material at temperatures ranging from 1173 to 1273°K and over a period of 250 hrs after load application. The results compare closely with experimental creep curves, allowing for some spread of test data. The results are also interpreted in terms of stress-strain curves indicating the mechanical behavior and in terms of microstructural analysis revealing formation of carbides ($Me_{23}C_6$ or Me C) during creep. Figures 4; tables 2; references 11: 9 Russian, 2 Western.
[84-2415]

NATIONAL CONFERENCE "PHYSICOCHEMISTRY OF AMORPHOUS (VITREOUS) METAL ALLOYS"

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, Jan 83 pp 63-64

KOVNERISTYY, Yu. K.

[Abstract] The conference was held 8 to 10 June 1982 in Moscow. Some 300 scientists and specialists heard and discussed 130 reports on pressing problems of research and development in the area of amorphou metallic materials, including the specifics of structure and physical-chemical properties of amorphous alloys, principles of creation of amorphous metallic materials, means of increasing their stability and improving processes of production of such materials. Topics covered included: research trends in the area of the physicochemistry of amorphous alloys; prospects for practical use of amorphous alloys; analysis of the structure of liquid and amorphous metals by statistical geometry and concentration distribution functions; the nature of the amorphous state; theory of structural relaxation of amorphous metal materials; diffusion and amorphous metals; physical and mechanical properties of emorphous alloys; and the powder metallurgy of amorphous alloys.
[65-6508]

NATIONAL SCIENTIFIC AND TECHNICAL CONFERENCE "MEANS FOR INCREASING STRUCTURAL STRENGTH OF METALS AND ALLOYS"

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, Jan 83, pp 60-63

KOT, O. P.

[Abstract] The conference was held 19-21 May, 1982 at Vil'nyus. Some 217 representatives of various machine building enterprises, scientific research institutes and universities from 27 cities took part in the conference. The reports and discussion were directed toward solution of problems related to estimating structural strrngth of modern metallic materials, the influence of structural and substructural specifics as well as metallurgical quality of alloys on fracture resistance, and optimization of the chemical composition and

hardening technology of metals and alloys. All reports covered general problems of structural strength and methods of its estimation, the structural strength of individual metal materials and the influence of various factors on it, and methods of increasing structural strength of various metal materials. [65-6508]

UDC 621.791:061.3

SECOND ALL-UNION CONFERENCE ON WELDING OF NONFERROUS METALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 83 pp 39-41

POPENCHENKO, T. I., engineer and SIDLIN, Z. A., candidate of technical sciences

[Abstract] The conference was held 40 to 6 October 1982 in Tashkent. Some 286 welding specialists from 107 organizations and enterprises in the nation took part. K. F. Akhmedov opened the conference. The deputy minister of higher and specialized secondary education of the Uzbek SSR, F. F. Megmatov described the current state of science and technology in the republic. Topics discussed at the conference included: improving metallurgy and the technology of welding aluminum and its alloys; status and problems of welding of chemically active and refractory metals and alloys; progressive and technological processes for welding of heavy nonferrous metals and alloys; study of weldability of secondary aluminum alloys; automatic welding; welding of light metals, titanium, refractory metals; weldability of granulated 1419 aluminum alloy; static and dynamic models of crystallization and structure formation in welded joints; new welding materials; specifics of electron beam welding; technology of welding tubular heat exchangers of aluminum alloys; electron beam welding of complex shapes of chemically active nonferrous alloys; alteration of the structure of titanium during pressure welding with steel; welding of molybdenum pipes; liberation of oxides during creep of welded joints based on niobium alloys; probability of development of pores in active metal welded joints; processes occurring in multilayer molybdenum-titanium materials during isothermal annealing; a control apparatus for electron beam welding of large products; reduction of electrolyzer cathodes based on nickel alloys; specifics of the repair of screw propellers made of copper based alloys; and development of welding materials for welding of manganese-copper alloys. [97-6508]

UDC 621.194:621.785.5

INFLUENCE OF ANNEALING ON CORROSION CRACKING RESISTANCE OF VMDIO-1 MAGNESIUM ALLOY

Moscow ZASHCHITA METALLOV in Russian Vol 19, No 1, Jan-Feb 83
(manuscript received 30 Nov 81) pp 120-124

TIMONOVA, M. A., D'YACHENKO, L. I., DOLZHANSKIY, Yu. M., AL'TMAN, M. B., SAKHAROVA, N. V. and BLYABLIN, A. A., All Union Scientific Research Institute of Aviation Materials

[Abstract] Previous research has shown that the corrosion resistance of VMD10-1 magnesium alloy can be enhanced by heat treatment, and specifically by annealing. The authors study the possibilities of optimizing heat treatment conditions to bring mechanical properties and corrosion cracking resistance of this alloy up to the level of present-day requirements. The study is based on principles of scientific design of experiments. Resistance to corrosion cracking was determined from the time to appearance of a visible crack on sheet specimens 2 mm thick by the method of set strain (stress of 200 MPa) with alternating loading in a 0.001% water solution of sodium chloride. To get a breaking point of at least 300 MPa with maximum corrosion cracking resistance, annealing must be done at 400-425°C for 2 hours. The yield stress of the annealed metal is 220-230 MPa, and relative longitudinal extension is about 15 %. Figures 3, references 8: 6 Russian, 2 Western.
[94-6610]

UDC 620.197.3

CORROSION LOSSES OF ShKh-15 STEEL AND Br. OS10-10 BRONZE FROM FRICTION IN WATER-ORGANIC SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 19, No 1, Jan-Feb 83 (manuscript received 27 Nov 82) pp 65-70

KROPACHEV, V. S., TOLSTAYA, M. A. and MUKHINA, M. G., Moscow Aviation Technology Institute imeni K. E. Tsiolkovskiy

[Abstract] In previous research, the authors have considered the corrosion-electrochemical behavior of ShKh-15 steel and Br. OS10-10 bronze with friction in water-organic solutions [see ZASHCHITA METALLOV, Vol 16, No 2, 1980, p 137; Vol 16, No 6, 1980, p 32]. This paper is devoted to a study of the corrosion component in the process of corrosion-mechanical wear of these alloys in water-organic solutions of various compositions. The friction couple comprised a disk and cylinder. Wear losses were determined from profilograms of friction tracks on the disk. Corrosion losses were determined from anodic polarization curves plotted by a potentiostatic method. The method of calculation is explained for like and dissimilar friction couples. On the basis of the results, an incombustible hydraulic fluid with optimum properties is proposed that contains accessible and comparatively inexpensive materials. The base is an aqueous solution of ethylene glycol (25-30 mass %) and polyethylene glycol (25-30 mass %, $M \cong 5000$). A polymeric thickener is added to extend the viscosity range. Cellosize was found to be the best thickening agent. As an inhibitor, the base contains trisodium phosphate. Various additives were tested for enhancing antiwear properties. The optimum fluid contains 27-28 mass % ethylene glycol, 27-28% polyethylene glycol, 0-1% Cellosize, 0.7-0.9% Na_3PO_4, 0.03-0.04% dioctyl sodium sulfosuccinate, and 0.4% 1,2,3-benzotriazole. Viscosity is 14-15 mm^2/s at 323°K, and wetting angle for ShKh-15 steel is 30-35°. Specimens showed no traces of corrosion after 720 hours of testing in this fluid. Figures 4; references 8: all Russian.
[94-6610]

UDC 620.785.53:620.194

NITRIDING EFFECT ON RESISTANCE OF AT3 AND AT6 TITANIUM ALLOYS TO CORROSION AND WEAR

Moscow ZASHCHITA METALLOV in Russian Vol 19, No 1, Jan-Feb 83 (manuscript received 29 Dec 81, after revision 22 Apr 82) pp 61-64

BORISKINA, N. G., KENINA, Ye. M., TUMANOVA, T. A., SHASHKOV, D. P. and MIKHALIN, V. M., USSR Academy of Sciences, Institute of Metallurgy

[Abstract] An investigation is made of the way that furnace nitriding under various conditions and glow-discharge nitriding affect AT3 and AT6 titanium alloys with respect to depth of penetration of nitrogen into the surface layers, wear resistance and corrosion resistance in 40% H_2SO_4 and 20% HCl at

20 and 60°C. Composition of the alloys (in %): AT3--2.7 Al, 0.2 Fe, 0.28 Cr, 0.24 Si, 0.02 C, 0.16 O_2, 0.03 N_2, 0.005 H_2; AT-6--5.0 Al, 0.28 Fe, 0.33 Cr, 0.29 Si, 0.03 C, 0.08 O_2, 0.02 N_2, 0.007 H_2. Parallel control studies were done on VT1-0 titanium. Furnace nitriding was done at normal pressure and temperatures of 900 and 1000°C for 1, 5 and 10 hours, and also at 850°C (1-20 hours) in steps of 5, 10 and 20 hours. Glow-discharge nitriding was done at 800, 900 and 1000°C in rarefield ammonia, or a mixture of ammonia with argon. Optimum nitriding conditions are determined that double or triple the wear resistance of these alloys, and improve corrosion resistance by two orders of magnitude in sulfuric and hydrochloric acids. References 7: all Russian.
[94-6610]

UDC 620.193.7

BEHAVIOR OF TITANIUM WITH HYDRIDE LAYER DURING ANODIC POLARIZATION IN SODIUM CHLORIDE SOLUTION

Moscow ZASHCHITA METALLOV in Russian Vol 19, No 1, Jan-Feb 83
(manuscript received 24 May 82, after revision 27 Aug 82) pp 55-60

MODESTOVA, V. N., TOMASHOV, N. D., CHERNOVA, G. P., DOROFEYEVA, V. N., PURYAREVA, T. P., GALAKHOV, M. V. and KASATKINA, I. V., USSR Academy of Sciences, Institute of Physical Chemistry

[Abstract] The anodic behavior of titanium with a hydride layer is studied in chloride solutions. The study material was VT1-0 titanium with globular structure in the form of a bar 8 mm in diameter and a sheet 1 mm thick. To minimize the influence of hydrogen on the electrode layer, most of the experiments were done on a rotating disk electrode. The anode was a platinum plate. The concentration of active chlorine was held constant during cathodic polarization at 0.007 n. The results show a potential delay of about 2 V in solutions of 1 n. NaCl with anodic polarization of hydrogenated titanium in the galvanostatic state. This delay is due to activated dissolution of titanium hydride taking place at elevated true anode current density. The hydrogen is released as gas. With increasing NaCl concentration, the potential of activated anodic dissolution shifts in the negative direction. Divalent sulfate ions retard the anodic dissolution of hydride due to adsorption displacement of chlorine ions. The rate of hydrogen liberation during hydride dissolution is constant in time and practically constant in potential as the pH is varied from 11 to 2.5, and increases in proportion to anode current density. Figures 4; references 14: 13 Russian, 1 Western.
[94-6610]

UDC 541.135.8:620.193.41

PHOTOELECTROCHEMICAL FORMATION OF SURFACE OXIDES ON TITANIUM

Moscow ZASHCHITA METALLOV in Russian Vol 19, No 1, Jan-Feb 83
(manuscript received 17 May 82) pp 47-54

KOSTINA, L. V., KUZNETSOVA, Ye. G., NOVAKOVSKIY, V. M., KASATKIN, E. V., LUBNIN, Ye. N., LAZAREV, E. M. and KORNILOVA, Z. I., Scientific Research Physico-Chemical Institute imeni L. Ya. Karpov, USSR Academy of Sciences, Institute of Metallurgy

[Abstract] Previous research has shown that dissolution of passive titanium is intensified by the action of light. On the other hand, it is known that light stimulates anodic formation of oxides with n-type conductivity on tantalum, tungsten, aluminum and bismuth. In this paper, an investigation is made of the composition, structure and some basic patterns of photoelectrochemical formation of solid-state products of corrosion of a titanium anode. Photoelectrochemical measurements were made in conjunction with Auger spectrometric, electron diffraction and electron microscope studies of the surface of the specimens, with ellipsometric observation of oxide formation, and with radiometric determination of the content of bound water. It is found that photoelectrochemical oxidation of titanium at a potential of 1.2-1.8 V under illumination of $\leqslant 0.16$ W/cm^2 leads to formation of both dissolved and solid-state corrosion products. The solid products are finely divided anatase and rutile containing somewhat less bound water than the usual anodic films on titanium. The rate of photoelectrochemical formation of oxides increases with increasing potential and illumination on the electrodes. The films do not have any appreciable protective properties, and thickness may reach a few tens of nanometers. Analysis shows that ultraviolet light somehow accelerates solid-phase recrystallization of the passivating film on titanium, irreversibly transforming it into dispersed corrosion products. Figures 4; references 20: 10 Russian, 10 Western.
[94-6610]

USING TRACK AUTORADIOGRAPHY IN CORROSION STUDIES OF BORON-CONTAINING ALLOYS

Moscow ZASHCHITA METALLOV in Russian Vol 19, No 1, Jan-Feb 83
(manuscript received 22 Mar 82, after revision 11 Aug 82) pp 24-30

KASPAROVA, O. V., KOLOTYRKIN, Ya. M., DEMBROVSKIY, M. A., MIL'MAN, V. M., KHOKHLOV, N. I. and SEVOST'YANOV, M. A., Scientific Research Physico-Chemical Institute imeni L. Ya. Karpov

[Abstract] The role of trace doping with boron on intercrystallite corrosion of stainless steels is studied by the method of track autoradiography based on the capacity of high-polymer detectors to fix tracks of charged particles that are products of the interaction of the lighter isotope ^{10}B with thermal neutrons: $^{10}B + {}^{1}n \rightarrow {}^{7}Li + {}^{4}He$. The study material was steel of type Fe-20%

Cr-20% Ni (0.01% B, 0.006% C). Cold-rolled sheets were quenched in water from temperatures of 1100 and 1200°C and etched in H_2SO_4. The specimens were irradiated with neutrons before and after etching. A nitrocellulose detector film 0.15 mm thick was pressed tightly against the specimen. Irradiation time was selected for optimum track density in the detector. After irradiation, the detector film was treated in NaOH, rinsed, dried and examined under an optical microscope. The limit of boron detection was 10^{-3} mass percent. It is found that the grain boundaries are enriched with boron in both the quenched and annealed state. In 1 n. H_2SO_4 at potentials corresponding to strongly oxidative media, boron is dissolved from the grain boundaries and intercrystallite corrosion develops. The method of track autoradiography is recommended for studying the role of trace amounts of boron in corrosion resistance of stainless steel. Figures 4; references 45: 16 Russian, 29 Western.
[94-6610]

UDC 620.193.43:669.14.018.85

HIGH TEMPERATURE SALT CORROSION OF HEAT RESISTANT STEEL AND NICKEL ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 6, Nov-Dec 82 (manuscript received 7 Nov 81) pp 92-95

MALYGIN, A. F., GUTS, A. V., YANKOVSKIY, Yu. V., YUSHCHENKOV, Ye. Ye.

[Abstract] Salt corrosion of heat resistant steel and nickel alloys was determined at 450 to 850°C and 900 to 1200°C, using pearlitic steel types 12KhMF, 15KhM, 23G2D, austenitic steels 12Kh18N10T, Kh20N32M3B, ferrite-martensite steel 05Kh12N2M, nickel alloy 08KhN70VMTyu, KhN60V, KhN75MBYu, KhN60BTKYu, KhN65VMTYu, KhN55VMTKYu, KhN55VMBTYu, KhN65VMTYu and nickel alloys KhN55VMTKYu, KhN65VMTYu, and KhN65VMTKYu and complex Al-Cr-Si-Y, Al-Ni-Si and Al-Ta-Si coatings. Tests were performed on plates and cylinders by wetting them with an aqueous solution of salts and holding them in air at the assigned temperature. Specimens were wet with a 5% solution of Na_2SO_4 (95%) plus NaCl (5%) each 20 hours. Tests times were 500 hours for steel, 2000 hours for nickel. It was found that corrosion rates of steels and alloys in contact with sulfate-chloride compounds are 10 and 100 times greater than corrosion rates of the same metals in air. High temperature salt corrosion can be accelerated by mechanically damaging the oxide film. A corrosion equation is suggested based on activation processes in the materials. For a number of structural materials it is found that the depth of high temperature salt corrosion can be estimated by linear addition of the effects of oxygen, sulfur and chloride corrosion. Figures 2; references 9: 6 Russian, 3 Western.
[89-6508]

UDC 620.194.2:669.295

HIGH TEMPERATURE SALT CORROSION CRACKING OF TITANIUM ALLOY INTERMEDIATE PRODUCTS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 6, Nov-Dec 82 (manuscript received 29 Jan 81) pp 72-75

SINYAVSKIY, V. S., USOVA, V. V., LUNINA, S. I., KUSHAKEVICH, S. A., MAKHMUTOVA, Ye. A., KHANINA, Z. K.

[Abstract] High temperature salt corrosion cracking of titanium alloy intermediate products, hot rolled plates and bars is studied. The materials included: the pseudo-α alloy VT20, and $\alpha+\beta$ alloys VT6 and VT14. They were compared with technically pure titanium and OT4-1 low alloy. Experiments were performed on ZST-3/3 and YaMB-2 machines under constant load at 400 and 500°C, stresses ranging from 40% to 90% of the yield point. Tests were at least 100 hours in length. The experiments showed that at 500°C a salt coating significantly accelerates fracture of the specimens at all stresses. Time to failure is decisively affected by test temperature and load. The salt coating has the most negative influence on the pseudo-α VT20 alloy containing up to 7% aluminum. Alloying with β isomorphic stabilizing additives increases high temperature salt corrosion cracking resistance. Vanadium or vanadium and molybdenum improve resistance. Low temperature annealing decreases the high temperature salt corrosion cracking resistance of VT20. Figures 3; references 11: 8 Russian, 3 Western.
[89-6508]

UDC 533.9

LASER METAL OXIDATION THERMO EMF MECHANISM KINETICS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 4, Feb 83
(manuscript received 24 Aug 82) pp 850-852

ALIMOV, D. T., BOBYREV, V. A., BUNKIN, F. V., corresponding member, USSR Academy of Sciences, KIRICHENKO, N. A., LUK'YANCHUK, B. S., MITIN, Yu. N., OMEL'CHENKO, A. I., SIMAKIN, A. V. and KHABIBULLAYEV, P. K., Physics Institute imeni T. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A new mechanism is suggested for the growth of the oxide film produced upon laser heating of metals. The mechanism produces an anomalously high contribution in comparison to ordinary thermal diffusion. Experiments were performed studying the oxidation kinetics of copper and cobalt. The copper target had a mass of about 220 mg, the cobalt about 70 mg. The targets were heated by a continuous CO_2 laser with a power of 25 W. Radiation intensity was varied by varying the focal spot diameter. Target temperature was maintained constant by varying target shape. The experimental curves agree well with the thermo-emf mechanism of oxidation proposed. Figures 1; references 6: all Russian.
[87-6508]

MINISTER DISCUSSES NEW METAL PROGRAM

Kiev PRAVDA UKRAINY in Russian 14 Dec 82 p 2

[Article by D. Galkin, UkSSR minister of ferrous metallurgy: "Comprehensively, in a Stewardly Manner"]

> [Text] The Metal Program is a document which specifies an aggregate of socioeconomic, scientific research, production, and organizational-management measures to achieve metal savings by improving quality, increasing output of the most efficient metal products, and expanding the product mix. The goals of the program are reflected and specific executing agencies named in the principal tasks, coordinated by timetable stages, sequence of development and adoption of new equipment and manufacturing processes, means of mechanization and automation, provision of component items and materials as well as financial resources.

We appraised the advantages of the specific-program method in planning improvement of quality during the 10th Five-Year Plan. While at that time principal emphasis in branch planning was placed on improving the directional thrust of scientific research and design activities, however, in the 11th Five-Year Plan stress is placed on maximum possible realization of technical and economic potential and expansion of the scale of adoption of the most effective results and on construction of industrial and experimental-industrial facilities which provide technical retooling and rehabilitation of ferrous metallurgical enterprises. This directional emphasis in branch development was specified by the decisions of the 26th CPSU Congress.

Projects involved in the Metal Program are coordinated by a specially formed UkSSR Gosplan and UkSSR Ministry of Ferrous Metallurgy council, with the council members assigned to the principal facilities. Area working committees have been established for implementation of the Metal Program.

The Metal Program contains 19 principal project tasks, each of which in the final analysis is directed toward a substantial improvement in the quality of metal products through improving the structure of steelmaking production, further expansion of production of rolled products of low-alloy steels, growth in production volume of heat-treatment strengthened rolled products, pipe and tube, wheels, as well as other technical and organizational measures.

Implementation of these tasks will be a concrete response to the decisions of the November (1982) CPSU Central Committee Plenum, which sharply and emphatically stressed that today economy and a concerned attitude toward the property of the people is a question of the practicability of our plans.

What is being done toward this end? For example, plans call for doubling by 1985 the processing of steel by so-called out-of-furnace methods. Extensive employment of out-of-furnace refining of molten steel, treating steel with synthetic slags, degassing, and microalloying make it possible substantially to reduce the content of harmful inclusions in the finished rolled stock -- sulfur, gases, and nonmetallic impurities. Such metal is more resistant to corrosion and has greater resistance to impact loads.

A most important directional emphasis in improving the quality of metal is improvement in the structure of steelmaking by giving priority to the development of oxygen-converter and electric-furnace steelmaking. Bringing on-line a new oxygen-converter shop with an annual output capacity of 2.8 million tons of metal at the Dneprovskiy Plant imeni Dzerzhinskiy, as well as an increase in the productivity of presently-operating converters will make it possible to boost oxygen-converter steel production to 40 percent in 1985 as compared with 34.8 percent in 1980.

The scale of employment of various methods of heat-treatment strengthening of finished rolled products is expanding: in particular, reinforcing steel by a factor of 2 , heat treatment hardened sheet and plate according to the "quenching and controlled rolling conditions" process by a factor of 8, and heat-treatment strengthened rails with heating by high-frequency current by a factor of 10.

Today there is virtually no enterprise in the industry to which scientific and technological advance would not apply. An additional set of equipment for rolling spring steel of an economical sectional shape is being installed on the 350-2 mill at the Makeyevka Plant. Work is in progress on designing improved general-purpose rolled structural shapes. In addition to reducing weight, these sections are distinguished by improved load-carrying capacity.

One of the serious factors holding back development in this industry was mentioned by CPSU Central Committee General Secretary Comrade Yu. V. Andropov in his address at the November Plenum. It consists in the fact that a substantial percentage of fixed assets in the iron and steel industry require renovation and rehabilitation. The Metal Program specifies a large volume of work toward this end. In particular, a modern 550 medium-section structural mill is being built at the Dnepropetrovsk Plant imeni Petrovskiy to meet the requirements of a number of branches and sectors of the economy in highly-efficient merchant shapes of constant and variable length section. The production volume for rolled products of low-alloy steels is targeted to increase by a factor of 1.7 in the 11th Five-Year Plan.

Many problems pertaining to further improving metal quality and increasing volume of production of the most efficient metal products, however, have not

been resolved. One of the most acute problems is the fact that the industry is poorly supplied with coking coal (which directly determines fulfillment of pig iron, steel and rolled products production plans), ferroalloys and alloying addition agents, essential in producing carbon and low-alloy steels.

In efforts to increase production of high-quality metal it is important fully to utilize all positive things we have achieved. In particular, in this industry we have experience in competition among workforces for high-quality steel. We should mention in this connection first and foremost the experience of the metallurgical workers of Donetsk, which has seen widespread adoption both in this republic and throughout the country. At this plant 93 percent of all steel is produced with a chemical composition which falls within a range which is narrower than GOST requirements. Meriting considerable attention is the initiative of Zhdanov steelmaker twice Hero of Socialist Labor G. Ya. Gorban', who issued an appeal for extensive combined socialist competition among metallurgical workers, machine-building workers, construction workers, and all workforces for improving quality and expanding the variety of metal products, reducing the metals requirements of machinery, equipment, and structural members, for economical and efficient utilization of metal in the nation's economy. This initiative won the approval of the Ukrainian Communist Party Central Committee.

Advanced know-how is of importance for organizing implementation of the decisions of the 26th CPSU Congress and the November (1982) CPSU Central Committee Plenum pertaining to meeting the requirements of the nation's economy in high-quality metal products, increasing reliability and durability of machinery, and reducing metal waste and losses at all stages of its production and consumption.

3024
CSO: 1842/64

UDC 621.78:621.311.04

GAS FURNACE HEATING OF NUCLEAR POWERPLANT PARTS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, Jan 83 pp 28-30

YEGOROVA, V. M., MOROZ, V. I., SOROKA, B. S., KHAZANOV, M. S., Central Scientific Research Institute of Heavy Machine Building, Gas Institute, Ukrainian Academy of Sciences

[Abstract] An experimental and mathematical study of heating of 4500 mm shell parts made of type 15Kh2NMFA steel is an automated gas shaft furnace 10 m in diameter and 7 m high with pulsed gas feed was performed in order to determine the distribution of temperatures through the volume of parts and its change with time, as well as the heat flux through the surface and the time required for temperature through the cross section of the parts to equilibrate. Calculations were performed by solving the differential heat conductivity equation by the method of finite differences. The experimental study was performed on a 4540 x 1059 x 212 mm shell with a mass of 24 tons installed on supports 1200 mm high, mass 16 tons in the furnace. Graphs of mean surface temperature and temperature drop through the cross section are presented. Analytic determination of the characteristics of heating of parts at various thicknesses and shapes can be achieved by solving the combined internal and external heat exchange problem. Figures 3; references 4: all Russian.
[65-6508]

DIRECTOR OF 'MEKHANOBR' INSTITUTE DISCUSSES MINERAL RESERVES

Moscow IZVESTIYA in Russian 7 Feb 83 p 2

[Article by USSR Academy of Sciences Corresponding Member V. Revnivtsev, director of the Mekhanobr Institute, Leningrad: "Reserve Potential for Miner Economy"]

[Text] In the last 25 years world consumption of mineral raw materials has been double the world population growth rate. Annual mineral production presently exceeds 10 billion tons, and this figure will at least double in the next 15 years.

Exploitation of natural resources is also proceeding at a rapid pace in this country. In this country, just as abroad, we are seeing a steadily growing scale of development of ore bodies with a useful constituent content which is considerably less than in the past, and hard-to-beneficiate ores, characteristic of which is an increasingly finer dispersion of the minerals to be recovered, are being increasingly more extensively drawn into processing. At the beginning of this century, for example, ores with a copper content of 5-6 percent were considered commercially minable, while today the figure has declined to half a percent and less. Therefore in order to obtain a single ton of metal, concentration mill operators frequently must process through hundreds and thousands of tons of crude ore. For example, in order to obtain a ton of copper today, one must process 100-150 tons of ore, while 1,500-2,500 tons of ore must be processed to produce a ton of tin, tungsten, or molybdenum.

In view of the present short supply of raw material resources, the process of mineral beneficiation assumes particular importance. Beneficiation alone makes it possible to exploit new, fairly large-volume sources of raw material, to achieve fuller utilization of ores, to engage in the commercial processing of tailings, etc. But a rapid change in the technical types of ore bodies characteristic of the present day is resulting in change in the entire technology of processing crude ore.

Several years ago our institute, just as other scientific organizations of this branch, was devoting principal attention to accomplishment of current specific tasks. Of course this had its advantages: assistance to enterprises in solving troublesome production problems is more visible, the time required to devise and adopt practical solutions is comparatively short, and economic effect is

considerable. Nevertheless, as we found from our own experience, efforts in this area could not provide for the branch's future growth and development.

It was necessary to effect radical reorganization of the institute's structure. Working together with organizations of the USSR Academy of Sciences and branch institutes of a number of ministries, we drew up a comprehensive program for developing and adopting more efficient reagents and high-output automated equipment. Implementation of this program will make it possible to bring into beneficiation processing substantial volumes of low-grade and hard-to-beneficiate ores, while maintaining the achieved level of recovery of copper, zinc, lead, tungsten and molybdenum, while increasing by 2-3 percent recovery of tin, rare and noble metals. It is projected that cost per ton of processed ore will be reduced by 10-15 percent. Labor productivity at beneficiation mills will increase by 15-20 percent.

Design of a cone breaker developed as a result of productive cooperation between our institute's scientists, the machinery engineers at Uralmashzavod, and Dzhezkazgan beneficiation mill operators serves as an example of implementation of a combined program connected with the development of new equipment. This machine has no counterpart anywhere in the world. It enables us to improve economic indicators at the preparatory operations stage and to achieve savings of up to 100,000 rubles for every million tons of processed ore.

An aggregate of activities aimed at developing and incorporating under commercial conditions industrial processes of nonferrous metal ore flotation employing new, efficient reagents is a component part of the specific-purpose program.

Our specialists succeeded, for example, in developing a synthetic oleic acid substitute, which is made out of a raw foodstuff. Research conducted at the institute has made it possible to propose a simple and no-waste process for producing a cheap and efficient reagent. Testing of this reagent at the Tyrnyauz Mining and Metallurgical Combine indicated that there is a realistic possibility of increasing metal recovery by 1-2 percent, producing a high-grade concentrate. Unfortunately the USSR Ministry of Chemical Industry is still taking its time about settling the question of commercial manufacture of this reagent.

A similar fate has befallen a number of other promising reagents. In order to get them into production, it is necessary to manufacture and test experimental batches at enterprises of chemical-industry ministries. Neither these ministries nor the enterprises themselves, however, have any interest whatsoever in turning out small quantities of new products for another industry.

Of course such hindrances impede implementation of this specific program. Nevertheless appreciable changes are already taking place in various branches thanks to this program. Employment of new processes, machinery, and unique technical solutions has made it possible to achieve more complete utilization of raw materials and to adopt the strategy of developing low-waste processes. The Verkhnedneprovsk Mining and Metallurgical Combine and the Belogorsk Mining and Beneficiation Combine are presently operating on a virtually no-waste process.

This institute's specialists have conducted extensive research in order to determine the influence of ore grade indicators on the concentration mill process at the Karagaylinskiy Mining and Beneficiation Combine and have devised a number of measures the adoption of which makes it possible to increase recovery of lead and zinc from ore, to improve the quality of the final product, and to reduce reagent consumption. To this I shall add that recovery of copper and zinc has increased by 3 percent as a result of implementation of an aggregate of measures at the Uchaly Combine.

Implementation of scientific project results specified by the combined program can produce the greatest effect at the junction of process stages: mining shop-beneficiation, and beneficiation-metallurgy. Typical in this respect is an approach to optimization of distribution of expenditures in breaking down the ore pieces in the "blasting-crushing-grinding" cycle. If we examine these three processes as an interlinkage, we see that with an increase in the specific consumption of explosives expended on breaking the ore loose, one can substantially reduce the consumption of electric power on crushing and grinding ore. This is precisely what happened at the Mikhaylovskiy Mining and Beneficiation Combine, where our recommendations have made it possible greatly to reduce the consumption of electric power. Electric power consumption was reduced by 50-60 percent at the coarse crushing stage, and by 8-10 percent in grinding.

We should note that today principal power expenditures are connected with the process of comminution. Placing emphasis on explosive removal and breaking of the ore, beneficiation mill operators can achieve a sharp intensification of the entire ore preparation process.

Today economy and a thrifty attitude toward what belongs to the people is a question of how realistic our plans are, as was stressed at the November (1982) CPSU Central Committee Plenum. Maximum economy of resources -- this is the goal toward which the scientists and engineers working on development of the mining and beneficiation industry are striving.

3024
CSO: 1842/76

TOWARD NATURE'S UNDERGROUND TREASURES: A REVIEW

Moscow DAILY REVIEW in English Vol 29, No 32, 15 Feb 83 pp 1-5

[Text] The development of industry hinges to a great extent on the availability of prospected mineral resources. In the present conditions, however, finding and surveying deposits of most minerals is becoming increasingly costly. This is due to the exhaustion of a possibility of major discoveries in the established mining industry areas; the natural deterioration of raw material quality in the interior; and the need to develop northern and eastern regions of the USSR, as well as shelf zones and deeper layers of the earth's crust.

This growth of material and financial outlays to discover and prospect mineral deposits can only be offset by scientific and technological progress, progress in fundamental and applied research into the earth's crust and upper mantle, including study of how mineral deposits are formed and distributed; and integrated investigations of deep-lying layers by means of geophysical and remote methods and super-deep drilling. All this helps to define scientifically the choice of optimum directions in geological prospecting. Secondly, this progress raises the level of technical equipment of geological prospecting and improves the organizational forms and technological methods of its conduct.

Deep Prospecting

To speed up this progress, it is essential to develop more rapidly progressive methods of geophysical and geochemical exploration of the earth's mineral wealth, to use widely in geology the possibilities of airborne and space means of studying the earth's natural resources; to apply more vigorously methods of accelerated geological and economic evaluation of deposits, and to ensure further technical re-equipment of geological prospecting organizations, and their supply with high-efficiency equipment, instruments and transport means.

"To carry out comprehensive studies of the depth structure of the earth's crust by means of deep and very deep boreholes and with the help of geological and geophysical methods and to determine the prospects of oil, gas and ores in the main areas of the country,"--this is how one of the key scientific and technical programs, being implemented in the eleventh five-year period, is formulated.

The head organization responsible for the fulfillment of the program is the Ministry of Geology of the USSR. Among the participants are organizations of the academies of sciences of the USSR and union republics, the Ministry of Oil Industry, the Ministry of Gas Industry, the Ministry of Higher Education, the Ministry of Heavy Engineering, and the Ministry of Chemical Engineering--in all, some 150 research and production bodies.

An important part of the program are regional geological and geophysical investigations to build typical models of the tectonosphere of regions with varying geodynamic situations as regards principal oil-, gas- and ore-bearing districts. Eleven deep and very deep boreholes are to be drilled. Together with geophysical studies, they will assist in solving not only fundamental problems but also a number of applied questions relating to the evaluation of oil, gas and ore prospects in the country's main geological industrial areas.

The drilling of the Kola and Saatlinskaya very deep holes continues. The drilling of the Tyumen, Anastasyevo-Troitskaya and Uralskaya boreholes 8 to 12 kilometres deep has started. Preparatory work is under way on six more holes. of these, the Dnieper-Donetsk, Prikaspiyskaya and Timanskaya ones are designed to explore the deep layers of these territories for oil and gas, while the Muruntau, Norilsk and Krivoi Rog boreholes will facilitate further studies of ore-bearing systems, development of the theory of ore formation, and improvement of the methods of deep prediction and evaluation of ore mineral deposits.

The program includes the development of new and the perfection of existing technical equipment for drilling and geological-geophysical investigation of deep and very deep boreholes. Thus, industry is to develop prototypes, and start the serial manufacture, of high-strength drilling pipes from light alloys, of high-strength ore-destroying drilling tools, of core-taking instruments, heat-resistant reduction-gear turbodrills, and a set of geophysical equipment for geophysical exploration at depths over 10 kilometers. In the design stage are highly mechanized drilling units with a lifting capacity of 500 tons. A search is being conducted for heat-resistant plugging materials and drilling fluids.

Among the key parts of the program is the compiling of space geological, tectonic and geophysical maps of principal oil-, gas- and ore-bearing areas of the country. That will provide the basis for prediction maps of major minerals.

The qualitative assessment of oil resources on the country's territory and in individual regions by January 1, 1984 will be specified, and optimum lines defined in prospecting for oil and gas in the 12th five-year plan period. There is considerable work in progress to improve the existing and introduce new methods of prediction and evaluation of deep horizons and flanks of exploited large deposits of solid minerals with a view to expanding the raw material resources for working enterprises. Feasibility studies are under way to extend them to a depth of 1.5 or 2 kilometers.

Arsenal of Geologists

Another comprehensive and target-oriented program serving to increase the efficiency of geological prospecting is the one called "Development of a set of methods and geophysical instruments to search and prospect for deep-lying deposits of oil, gas and other key minerals." Taking part in its implementation are organizations and enterprises of 12 ministries and departments. The ministry in charge is the Ministry of Geology of the USSR.

The complex of geophysical instruments includes multi-channel seismic stations, including those with telemetric sending of signals and numerical recording of information for subsequent processing on large computers, computerized multi-parameter well-logging units to investigate boreholes, and an electric prospecting station for operation with powerful current sources. These instruments will improve the accuracy, depth and resolving ability of geological and geophysical information, and raise the productivity and efficiency of seismic, electric prospecting and well-logging operations.

The program provides for developing highly efficient equipment to drill boreholes down to two kilometers for solid mineral resources.

Introduction of new drilling equipment will make it possible to discover mineral deposits at great depths with more efficiency, and to raise the productivity of drilling by 1.2 times. Altogether, there are 44 assignments regarding new technical means. Some preliminary research has been done already for them, and for some of them there are preparatory design results. Only six assignments have been planned for the 12th five-year period. All the rest must be carried out before 1986.

As a result, the geological industry, as well as oil and gas industries, will be equipped with new highly efficient methods and technical means allowing labor productivity in geophysical work to at least double, with a reduction of their costs by 33 percent. The economic returns from applying the new devices will amount to 700 million rubles by 1985, and over one billion rubles by 1990.

Successes

The results of the past two years indicate that both programs are, on the whole, being carried successfully. Among the most effective developments, mention should be made of oil-filled reduction-gear turbodrills that increase drilling rates by 1.5-2 times per bit.

Studies of the cross-section of the Kola very deep borehole have yielded unique data on the structure of deeper layers of the earth's crust, their temperature and ore formation conditions. These data have disproved some of the earlier hypotheses. By the beginning of this year, the depth of the Kola borehole exceeded 11.5 kilometers, while that of the Saatlinskaya one in Azerbaijan reached 8.2 kilometers.

The reaching of such record depths, previously unattainable to anyone in the world, was a serious test for Soviet metal-making, chemical and engineering industries. The equipment has shown excellent service. The engineering calculations have fully justified themselves. Soviet scientists have been the first to take a "look" at such deep-lying mysteries of the earth.

A considerable volume of research has been carried out, working documentation has been prepared on some types of geophysical instruments and drilling equipment, and prototypes of well-logging instruments and a complex of technical means with an electric drive to sink underground mining prospecting workings of small cross-section, have been built. The Progress and Progress-3 numerical seismic stations are in serial production, as are various types of non-explosion exciters of seismic waves.

The Progress-3 station can operate with sources of seismic oscillations of any type. Another great success is the Gorizont seismic prospecting station, which sends geophysical information along 24-96 channels and processes it with the help of microprocessor sets and means of deep prediction. Research work is also in hand to develop a field seismic prospecting complex (up to 500 channels) with a telemetric system of signal transmission.

The review has been compiled by the mineral resources department of the USSR State Committee for Science and Technology.

(Ekonomicheskaya Gazeta No 5, January 1983. Abridged.)

CSO: 1852/9

KAZAKH NONFERROUS METALLURGY'S USE OF SCIENTIFIC RESULTS PRAISED, CRITICIZED

Alma-Ata VESTNIK AKADEMII NAUK KAZAKHSKOY SSR in Russian No 10, Oct 82 pp 39-45

[Article by R. V. Musalayeva: "The Utilization Effectiveness of Scientific Achievements in Kazakhstan's Nonferrous Metallurgy"]

[Text] The role of science in raising the effectiveness of social production and in improving economic relationships and management of the economy is growing in the modern era of developing the Soviet economy. Introduction of the achievements of scientific and technical progress into the country's economy is becoming more intense. As CPSU Central Committee General Secretary Comrade L. I. Brezhnev noted, "...further intensive development of science and technology and wide introduction of the latest achievements of science and technology into production...are becoming important political tasks."[1]

Raising the effectiveness of scientific and technical progress in Kazakhstan's nonferrous metallurgy--one of the leading branches of the republic's industry--depends greatly upon building up and improving the industry's science and technology potential. Its share in the output of goods is 17 percent. In lead, zinc and cadmium production, Kazakhstan is in first place in the Union. More than 40 specific nonferrous, noble and rare-earth metals, as many as 70 types of rolled nonferrous metals, salts and oxides, sulfuric acid, machine-building articles, and supplies for the building-materials industry are now being produced.

Kazakhstan's nonferrous metallurgy is marked by high technical and economic effectiveness. Through the introduction of new productive capacity for mining and processing ores and expansions of existing capacity, commodity output has doubled in the past decade. Each year the technical level of production is raised. The proportion of its mechanized equipment has risen almost 1.3-fold, outstripping the increase in the capital-labor ratio. The electric power-to-worker ratio has increased 1.4-fold, while the rise in the energy-to-worker ratio was 1.6-fold.

During the 10th Five-Year Plan the share of output with the state's Emblem of Quality in the industry's overall output volume grew by more than 10 percent.

Much work has been done on the integrated mechanization and automation of industrial processes, and the number of mechanized departments at enterprises has grown 5.7-fold. The mechanization level has reached 87 percent. The number of automated

[1]L. I. Brezhnev. Leninskim kursom. Rechi i stat'i [By a Leninist Policy. Speeches and Articles]. Moscow, Vol 2, 1970, page 346.

sections has increased 31.4 percent, and 10 automated control systems for industrial processes and 4 computing-and-information centers have been put into industrial operation.

Where there has been a lag in developing the raw-materials base, the degree of raw-materials utilization and the integration of raw-materials processing must be raised during all conversion processes. Forty-nine elements of Mendeleyev's Periodic System are now involved in commodity output at Kazakhstan's nonferrous metallurgy enterprises. During the 10th Five-Year Plan a number of these enterprises, such as the Zhayrem and Zhezkent Mining and Concentrating Combines, the first line of a new concentrating mill of the Karagayly Mining and Concentrating Combine, a department for upgrading ores in heavy suspensions at the Tekeli Lead and Zinc Combine, the rare-earth metals department at the Dzhezkazgan Mining and Metallurgical Combine, a complex of rolling mills at the Balkhash Mining and Metallurgical Combine, and others have been put into operation.

In the past decade a reduction in prime production costs of commodity output (almost 18 million rubles per year and a conditional release of workers (more than 750 people per year) have occurred as a result of scientific and technical measures.

Introduced during the 10th Five-Year Plan were more than 100,000 rationalizers' suggestions (114.7 percent in comparison with the Ninth Five-Year Plan) and 1,500 inventions, with a saving of about 150 million rubles from introducing them.

The 26th CPSU Congress set before the country's nonferrous metallurgy workers important tasks that would strengthen the raw-materials base, improve the technology of mining and of processing ores and concentrates, and increase integration in raw-materials utilization. The necessity for speeding up the introduction of autogenous, hydrometallurgical and microbiological processes and improving the quality and assortment of output produced was emphasized.[2]

One of the ways to satisfy more completely the requirements for nonferrous metals is to speed up realization of the newest scientific and technical developments in nonferrous metallurgy. The use of scientific and technical achievements in production is accompanied by a growth in labor productivity, improvement in output quality, and the introduction of new types of raw materials, other materials and energy. "The most decisive and the most critical area of activity today is the introduction of scientific discoveries and inventions," L. I. Brezhnev emphasized at the 26th CPSU Congress. "Scientific research and design development should join more closely--economically and organizationally--with production...."[3]

The republic's Ministry of Nonferrous Metallurgy did a lot of work during the 10th Five-Year Plan to accelerate the development and introduction of new, progressive industrial processes and equipment and the mechanization and automation of production processes. Production outlays during the five-year period were reduced by 95.6 million rubles, which is 15 percent higher than the Ninth Five-Year Plan's level, by introducing new equipment. Scientific research was performed on more than 550 projects in Union, republic, USSR Ministry of Nonferrous Metallurgy and agency plans. Expenditures for performing scientific research

[2]See Materialy XXVI s"yezda KPSS [Papers of the 26th CPSU Congress]. Moscow, 1981, page 152.
[3]Ibid, page 43.

and experimental development work were 81.2 million rubles, versus 74 million rubles during the Ninth Five-Year Plan. Tens of research subunits, where more than 1,000 people work, are now operating at the ministry's enterprises. The amount of scientific-development work that is being performed in the industry has grown more than 1.3-fold during the 10th Five-Year Plan. The effectiveness of expenditures on scientific research (NIR) is 1-14 rubles.

The period for recouping expenditures on introducing new equipment in the lead-and-zinc industry, for example, is not long, averaging 0.93 year during the 10th Five-Year Plan, while the industry's average indicator was 1.57 years, consisting, by field, of: 1.2 years for mechanizing production, and 1.3 years for modernizing equipment. The automation of production (2.2 years) and the introduction of computer equipment took the longest periods for recoupment.

NIR expenditures increased from 1.46 million rubles in 1975 to 1.76 million in 1980 because of the increase in research in nonferrous metallurgy.

It is planned to build industrial test bases at enterprises and industrial test installations in order to provide scientific research with materials and equipment and to check on NIR results with industrial testing. It is proposed to spend 1.4 million rubles for these purposes during the 11th Five-Year Plan. In particular, the budget-estimated cost for expanding the experimental and test shop and for building an industrial-test installation for the distillation of arsenic at DzhezkazganNIPItsvetmet [Dzhezkazgan Scientific-Research and Design Institute for Nonferrous Metallurgy] is 1 million rubles.

Scientific and technical achievements are being used widely at the republic's nonferrous metallurgy enterprises. At ore-mining enterprises, open-cast mining operations have practically been completely reequipped. Scientific research is proceeding in the area of reducing ore losses during mining. VNIItsvetmet [All-Union Scientific Research Institute for Nonferrous Metallurgy] and the Institute for Mining Affairs of the KazSSR AN [Academy of Sciences] are studying rational methods for the secondary excavation of reserves of useful minerals, and Giprotsvetmet [State Institute for the Design of Nonferrous Metallurgy Enterprises] and DzhezkazganNIPItsvetmet are working jointly with KazSSR AN's IGD [Institute of Mining Affairs A. A. Skochinsky] on developments for the secondary working of the Dzhezkazgan field.

Concentrating plants, for the first time in the country, have mastered the preliminary upgrading of ores in heavy suspensions.

In the area of metallurgical production, scientific research has been aimed at raising the degree of integration of raw-materials processing and at involving substandard raw materials and production waste in processing.

The Institute of Steel and Alloys, KazSSR AN's Institute of Metallurgy and Concentration (IMiO) and Giprotsvetmet are developing jointly with the Balkhash Mining and Metallurgical Combine a technology and the equipment for smelting copper concentrates in a "liquid bath."

In order to conduct NIR in the area of mechanization of processes and to develop and create new equipment and means for mechanization, 2.5-3.5 million rubles are being appropriated per year. During the 10th Five-Year Plan more than 150 major measures for mechanizing labor-intensive processes were introduced at enterprises.

A number of scientific operations carried out with scientific collectives and with the participation of production workers received wide recognition both in our country and abroad. Thus, works on rhenium that IMiO performed jointly with the Balkhash Copper Smelter were recognized with the USSR State Prize. Developments for acquiring rare-earth metals by VNIItsvetmet and UKSTsK [Ust-Kamenogorsk Lead and Zinc Combine] were awarded the Lenin Prize.

An operating scheme for processing lead-containing dust and sublimates that was developed by VNIItsvetmet, a technology for processing new types of aluminum raw materials that was devised by IMiO, KazPTI [Design and Technological Institute] and VAMI [All-Union Scientific-Research and Design Institute for the Aluminum, Magnesium and Electrode Industries], work by VNIItsvetmet and other institutes to use oxygen to intensify nonferrous metals production, kivtsetnaya [cyclonic-electrothermal oxygen suspension] smelting, and many other developments that have been introduced into production with great economic benefit have enabled the technical and economic indicators of metallurgical enterprises to be improved and nonferrous metals production volume to be increased. A major contribution to speeding up scientific and technical progress in the republic's nonferrous metallurgy was made by KazSSR AN's Institute of Metallurgy and Concentration. Its developments have found wide application at the BGMK [Balkhash Mining and Metallurgical Combine] DGMK [Dzhezkazgan Mining and Metallurgical Combine], IPK, LPK [Leninogorsk Polymetals Combine], PAZ, ChSZ, UKSTsK and UKTMK and other enterprises. During the 10th Five-Year Plan the institute introduced about 80 works into the economy with an economic benefit of more than 20 million rubles. The effectiveness of expenditures on scientific research was 1.88 rubles per ruble. In 1980 the institute put into production 11 works with an economic benefit of more than 2.5 million rubles.

The technology for obtaining alumina from low-grade bauxite raw material was introduced at PAZ with an economic benefit of more than 100,000 rubles. The work was awarded the USSR State Prize in the area of science and technology for 1980. At PAZ, and also at the Tikhvin Alumina Plant, the technology for obtaining gallium by cementation of its aluminum gallate was mastered. The total economic benefit was 2.9 million rubles. At ChSZ the technology for sorption extraction of rhenium from washing-tower solutions and from the hydraulic department's electrical filter was introduced, with an economic benefit of 50,000 rubles; and a method for scrubbing sulfate solutions from colloidal and weak suspensions of carbon sorbent was introduced with a benefit of more than 350,000 rubles. At the Novosibirsk Tin Combine the continuous vacuum process for refining tin was mastered. An economic benefit of 2.6 million rubles was obtained. At the Pikalev Alumina Plant of USSR Mintsvetmet [Ministry of Nonferrous Metallurgy], the technology for extracting gallium from a mother potash solution was mastered with an economic benefit of 0.5 million rubles. At UKTMK the technology for scrubbing tetrachloride of titanium from mixtures by means of aluminum powder was introduced, and the economic benefit was 221,000 rubles.

However, organization of the practical realization of scientific achievements in the industry and the introduction thereof into mass production are weak links in the "science and production" cycle. Time spent for development, from the birth of an idea to its assimilation in production, is often measured as 7-10 years, which leads to obsolescence of the equipment and loss of the innovation's economic effectiveness. The bottleneck that impedes the pace of scientific and technical progress is not the lack of promising ideas and scientific discoveries but the unsatisfactory assimilation of the results of completed NIR and of experimental design developments (OKR's).

An analysis of the results of introducing NIR that has been developed in the KazSSR AN's IMiO and of the time spent between the emergence of an idea and its realization in mass production indicates that the average time period for realization of an institute's development is 4-5 years. Thus, out of 37 works introduced during the five-year plan that we analyzed, four works spent 9-10 years in the "idea-to-research-to-hardware-to-production cycle," four spent 6-7 years, 28 works spent 3-5 years, and one work spent 2 years. Measures introduced during the 10th Five-Year Plan in the republic's lead-and-zinc industry spent, on the average, 4-6 years in the "research to production" cycle. In particular, for the Zhayrem GOK [Mining and Concentrating Combine] it was 7.8 years, including a "research" stage of 4.8 years, or 61.5 percent of the duration of the entire cycle. The main part of the expenditures went to the "scientific-research" stage (38 percent), 40 percent to the "introduction" stage. The ratios were the same for the Karagay and Akchatau Mining and Concentrating Combines. Stages in the science-to-production cycle are spent in the various research collectives, particularly the academic institutes, and in industry scientific-research institutes and design-development organizations, and at bureaus and enterprises. Consequently, the duration for each stage depends also upon the organization of work in these collectives, and a reduction in the time for each stage of the scientific production cycle means a reduction of the whole cycle.

In 1980 VNIItsvetmet completed 135 scientific projects, but only 33 developments (24 percent) were introduced, and, for IMiO, 64 percent of the completed works were introduced. The basic causes of this situation are poor support of the work with design documents and financing resources, the long time spent building installations and departments, and difficulties in the serial output of the equipment developed because of a lack of appropriate large machinebuilding plants. The lack of or the low capacity of experimental-test bases greatly hampers the conduct of scientific research and the introduction of its results into production. There are, moreover, inadequate provisioning of institutes with modern, unique, specially imported equipment; the small sizes of the appropriations for conducting pilot testing and experimental industrial testing, the lack of funds for designers' surveillance over the use of the results obtained, and the lack of a system of material incentives for introducing developments (the lack of material incentives on the part of scientific staff workers to achieve the greatest economic effectiveness of the work).

The pace of technical progress is being held back by the long time spent developing and introducing new, progressive technological processes. Questions of the integrated use of raw materials are being resolved slowly. Millions of tons of slag are piling up at lead plants, but it is being processed only at UKSTsK and Achpolimetall.

For many problems of nonferrous metallurgy there are already scientific results and design solutions, but they are not being put into production because of the limited nature of the funds allocated.

Work to create some means for mechanization are stretched out over many years; many enterprises of the industry do not have an experimental base; and the pace of construction of facilities for new equipment is inadequate--by the time the facilities are turned over the designed equipment and technology are obsolete. Most often of all, the introduction of scientific and technical achievements is held back because of inadequate provisioning with materials and equipment and because of delays in construction and installing operations. Because of the limited allocations,

capital investment is aimed primarily at building facilities that increase an enterprise's productive capacity, while measures that reduce the prime operating costs and labor intensiveness of the output are executed incompletely. Moreover, industry is slow in mastering new equipment and technology.

In the republic's nonferrous-metallurgy practice, problems that hinder the wide introduction of scientific and technical achievements into production are being resolved by changes in the organizational and economic relationships among scientific, design and production collectives. The links of scientific institutions with production enterprises are being followed up at all stages of operations, beginning with substantiation and inclusion in the plan, with studies and theoretical research, and ending in the creation of a test model and with the introduction of the research results into production. Not only such traditional forms of linkage as economic agreements are being used widely, but also new forms that have been disseminated recently in the country's leading scientific centers.

In nonferrous metallurgy, it is the practice to combine the development of research plans by enterprise institutes and by such institutes as VNIItsvetmet, Kazgiprotsvetmet [Kazakh SSR Institute for the Design of Nonferrous Metallurgy Enterprises], Mekhanobr [All-Union Scientific-Research and Design institute for the Mechanical Treatment of Useful Minerals], Kazmekhanobr [Kazakh SSR Scientific-Research and Design Institute for the Mechanical Treatment of Useful Minerals], which enables avoidance of duplication of projects and of work on trivial topics and focuses the main efforts on solution of the most urgent problems. At the Leninogorsk Polymetals Combine, research and development tests are being conducted each year on more than 40 topics with the involvement of 20-25 institutes. Expenditures are less than 1 million rubles but the yield is more than 2 rubles per ruble spent. During the five-year plan, using scientific and technical achievements and scientific organization of work, economic benefits of 930,000 and 2.9 million rubles were gained at LPK's lead plant and zinc plant, respectively, the conversion into final product increasing by 3.5 percent for zinc, 1.4 percent for lead and black lead. The main developments introduced at LPK were the improvement of electrothermal methods for treating lead-containing industrial products and secondary raw materials, the introduction of schemes for the hydrometallurgical treatment of zinc cake, and so on.

One of the effective means for speeding up the introduction of scientific achievements is the conclusion of agreements on creative socialist collaboration with industry institutes and with enterprises, and also the creation of bilateral and integrated creative interindustry brigades. At present, an interagency integrated creative brigade made up of representatives of UKTMK, Kazmekhanobr and KazSSR AN's IMiO is in operation. Production workers are extending every assistance in the introduction of scientific developments, scientific workers are performing designers' surveillance over the status and scale of introduction, scientific-consultative assistance is being given to the enterprise in the matter of the proposed methods and industrial processes, help is being given in regard to publications and supervision, and so on.

A program for the creative collaboration of the Ust-Kamenogorsk Lead and Zinc Combine, VNIItsvetmet and Kazgiprotsvetmet, which includes tasks of the current plans and long-term prospective plans, is in operation. The plan includes 15 large scientific-research and design-development operations in the field of zinc-and-lead production, a combining of chemical and metallurgical production, and the scrubbing of industrial gases and effluent. The plan for reequipping combines during

1975-1990 calls for replacement of the blast smelting of lead agglomerates by flame smelting; the introduction of KS-800 furnaces for treating zinc-sulfide concentrates; the introduction of double contacting in sulfuric acid production, and so on. In 1980 the economic benefit from completed projects carried out by VNIItsvetmet and introduced at UKSTsK was about 1 million rubles.

In various scientific institutions integrated brigades are made up from representatives of the prime institute and other involved institutes and enterprises. There is such experience in Kazmekhanobr in regard to development of the ores of the Sayak field and for the scrubbing of mill effluents with liquid chlorine. Moreover, the link with production is effected through the acceptance of intermediate results, experimental industrial testing, and designers' surveillance at the industrial introduction stage, as well as through participation of institute staff workers and enterprise workers in the operations of the Scientific Council, trusteeship on controversial questions, visits by scientific-institution specialists to enterprises for extending scientific-procedural assistance, the forwarding of conclusions and suggestions, and so on.

Economic agreements are among the important forms of the links of science with production. The introduction, the testing and the industrial-test verification of the results of scientific research are performed at enterprises on the basis of them. Each year KazSSR AN's IMiO concludes more than 50 agreements.

Another progressive form of link of science with production is work on long-term integrated scientific and technical programs. Under these programs, such important work as the development and introduction of autogenous processes and processing of polymetal raw materials (the cyclonic-electrothermal oxygen suspension method of smelting, and smelting in a liquid bath) is being conducted at BGMK and IPK.

Integrated scientific and technical programs specify the final object of the work, the deadlines and the sources for financing and supplying of materials and equipment, and they determine the enterprises that will perform industry verification and introduction of the work.

The KazSSR Academy of Sciences developed in 1980 several integrated programs on nonferrous metallurgy problems, including a program for developing and mastering the technology of the integrated utilization of spent vanadium catalysts; of hydrometallurgical processes for underground, pile and vat leaching and extraction of nonferrous and noble metals; and of progressive autogenous processes for processing sulfide metallurgical ores.

Under the coordination plan for joint research with USSR Ministry of Nonferrous Metallurgy and the USSR Academy of Science's Institute of Metallurgy and Concentration, the KazSSR AN is conducting 16 operations. Among them are developments in the vacuum refining of tin, lead and cadmium, the vacuum pyrorefining of gold-antimony, gold-arsenic and mercury-antimony concentrates, the integrated use of nonferrous metallurgy slags, and so on.

Thus the intensive use of scientific achievements in Kazakhstan's nonferrous metallurgy, the most rapid introduction of research results, and reduction in the research-to-production cycle are most important routes for speeding up scientific and technical progress and raising its effectiveness in industry.

11409
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METALLURGICAL INDUSTRY OF EASTERN KAZAKHSTAN INTRODUCES ADVANCED METHODS, TECHNIQUES

Alma-Ata KAZAKHSTANSKAYA PRAVDA in Russian 27 Nov 82 p 2

[Article, published under the heading "Science to Production," by A. Sedchenko, party committee secretary, All-Union Order of the Red Banner of Labor Mining and Metallurgical Scientific Research Institute for Nonferrous Metals: "Stages of Cooperation"]

> [Text] The scientists and metallurgical workers of Kazakhstan have read with great interest the documents of the November CPSU Central Committee Plenum and the speech presented at that plenum by CPSU Central Committee General Secretary Yu. V. Andropov. Vigorously responding to the plenum decisions, the workers, engineers, and scientists of Eastern Kazakhstan's metallurgical industry are extensively adopting advanced know-how pertaining to retooling and rehabilitating enterprises and are strengthening the bond between science and production.

In recent years the workforces of Eastern Kazakhstan's nonferrous metallurgical enterprises, working in cooperation with scientists at VNIItsvetmet [All-Union Scientific Research Institute of Nonferrous Metallurgy] and other institutes, have developed, adopted and put into operation a number of fundamentally new industrial processes and process equipment. The most significant ones in the mining industry include forced block caving, underground ore extraction employing self-propelled equipment, "squeeze" breaking ore with deep blast holes, and mining systems incorporating filling in mined-out space. The percentage share of high-productivity production systems at the mines in the oblast reached 80 percent by the end of the 10th Five-Year Plan. Labor productivity for mining-face workers at the mines increased by a factor of 2-3. At the present time ore mining employing advanced technology and filling in of mined-out space has reached 42 percent.

Further increase in labor productivity at the mines is being achieved by means of extensive employment of high-output self-propelled equipment, which has made it possible to mechanize all stages of ore extraction. Employment of this equipment is boosting labor productivity during entry and on the mining face.

The scientifically substantiated drilling and blasting standards proposed by VNIItsvetmet have been widely adopted not only at mining enterprises in the

Altay and Kazakhstan, but also in surface mining operations in Siberia, the Far East, the Caucasus, and the Urals. Adoption of these standards at 11 of this industry's open-pit mines in the 10th Five-Year Plan produced savings of more than 1,000 tons of explosives and eliminated the drilling of approximately 100 kilometers of blast hole.

The processes of preliminary concentration of complex ores in heavy suspensions are being extensively employed at the mines in this oblast. Heavy suspension shops have been designed, built and are in operation at the Zyryanovsk, Leninogorsk, and Belogorskiy combines, based on design work done by VNIItsvetmet and developed in cooperation with other institutes and enterprises in the USSR. The new concentration process has produced additional hundreds of thousands of tons of nonferrous metals and non-ore materials, has brought low-grade and zabalansovyye [not included in reserves of commercially-minable ores] ores into processing, and has significantly strengthened the ore base of this republic's nonferrous metallurgical industry. Consumption figures for toxic reagents and fresh water have been reduced by one third. Comprehensiveness of utilization of crude ore has increased.

At the present stage of development of the nation's economy, improvement of the efficiency of utilization of natural resources has been advanced to the ranks of important scientific and technical problems. The Ust-Kamenogorsk Lead and Zinc Combine, working jointly with VNIItsvetmet and Kazgiprotsvetmet, initiated the comprehensive utilization of crude ore.

As a result of the cooperative effort by metallurgical workers and scientists, the Ust-Kamenogorsk Lead and Zinc Combine has achieved the highest lead recovery among all this country's lead plants -- 97.5 percent. At this combine the comprehensiveness factor is 92.3 percent in zinc production and 95.8 percent in lead production. At the present time 17 elements are being recovered from complex ore, resulting in 29 merchantable products.

The Ust-Kamenogorsk Lead and Zinc Combine constitutes an example of industrial utilization of oxygen in the nonferrous metallurgical industry. Employment of oxygen in shaft-furnace lead smelting has made it possible to speed up the process and substantially to reduce consumption of fluxes. In roasting zinc concentrates, oxygen has increased fluidized-bed furnace output by 60-70 percent.

Scientists from the Kazakh SSR Academy of Sciences, VNIItsvetmet, engineers and technicians at the Irtyshsk Complex Ore Combine developed and brought on-line, a world first, the KIVTSET [Oxygen-Suspended Cyclone-Electrothermal Method of Autogenous Smelting] method of autogenous smelting of copper-zinc concentrates. Construction is presently in progress on a commercial installation for KIVTSET smelting of lead concentrates at the Ust-Kamenogorsk Lead and Zinc Combine. KIVTSET has been patented in many foreign countries.

A group at the Ust-Kamenogorsk Lead and Zinc Combine, VNIItsvetmet and Giprotsvetmet was awarded a Lenin Prize in 1961 for successes achieved in the area of comprehensive utilization of raw materials, employment of oxygen, and other unique technical developments. Lenin Prize recipients included

V. Vartanyan, I. Kotov, L. Kozlov, V. Varlamov, V. Fel'dman, and others. A USSR State Prize was awarded in 1971 to a group of people at VNIItsvetmet, the Ust-Kamenogorsk Lead and Zinc Combine, the Chimkent and other lead plants for development and incorporation at this country's lead plants of a process for recovering noble metals employing electrothermics. Prize recipients include well-known innovators in nonferrous metallurgy I. Kershanskiy, I. Voronin, V. Kuur, R. Khabdabergenov, and V. Pron'kin. Another achievement came in 1980: a USSR State Prize was awarded to a group of scientists at the Kazakh SSR Academy of Sciences, VNIItsvetmet, and the Irtyshsk Complex Ore combine for the KIVTSET method of smelting complex ore concentrates. Prize recipients include A. Kunayev, A. Sychev, S. Omarov, V. Kostin, and other leading scientists of this republic.

Integration of science with production is an urgent demand of the times. Having studied the experience pertaining to retooling and rehabilitation of nonferrous metallurgical enterprises, the East Kazakhstan Oblast Committee of the Kazakhstan Communist Party issued a decree specifying further development of productive cooperation between this industry's scientific research institutes and industrial enterprises. A productive cooperation plan was drawn up between VNIItsvetmet and the Ust-Kamenogorsk Lead and Zinc Combine. Scientists, working together with specialists at the combine and Kazgiprotsvetmet, have begun implementing a unified program for improving production. This has fostered the adoption of many effective measures. The commercial utilization of oxygen in metallurgical production was approved by the CPSU Central Committee.

Productive cooperation between production specialists and scientists is continuously evolving and growing stronger. At the present time VNIItsvetmet has 39 long-term development agreements with scientific, academy, and academic institutes and with all this country's leading lead and zinc enterprises.

One can cite many examples of fruitful cooperation between VNIItsvetmet and the Ust-Kamenogorsk Lead and Zinc Combine pertaining to installation and start-up of large unit capacity roasting furnaces and facilities for processing sublimates; with Vostokmashzavod -- on development of new mining machinery. Jointly with the East Kazakhstan Copper-Chemical Combine, we are bringing on-line a process to concentrate complex ores at the Nikolayevskiy Mill; with the Irtyshsk Complex Ore Combine -- a KIVTSET complex and sulfuric acid production.

Indicative in this respect is the experience of joint activities by VNIItsvetmet and the Leninogorsk Complex Ore Combine: during the 10th Five-Year Plan 25 project results were adopted at the combine, generating savings of 9 million rubles. During the five-year plan the institute brought on-line the results of 165 projects, generating an aggregate savings of more than 56 million rubles.

As a result of close cooperation between science and industry, considerable scientific and technological potential has been created in nonferrous metallurgy, which is of great importance for our country's entire economy. Fuller utilization of this potential will foster further intensification of production and increased production efficiency, as specified by the decisions of the 26th CPSU Congress.

3024
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EFFECT OF POWDER METALLURGY: TECHNOLOGICAL ADVANCE AND ECONOMICS

Leningrad LENINGRADSKAYA PRAVDA in Russian 14 Dec 82 p 2

[Article by USSR Academy of Sciences Corresponding Member A. Manokhin, director of the USSR Academy of Sciences Institute of Metallurgy imeni A. A. Baykov: "The Effect of Powder Metallurgy: Technical Progress and the Economy"]

[Text] The Problems of Powder Metallurgy All-Union Scientific Conference, dedicated to the 200th anniversary of the birth of eminent Russian metallurgist Petr Grigor'yevich Sobolevskiy, corresponding member of the Russian Academy of Sciences, is convening today in Leningrad. On 21 March 1827 he presented a paper entitled "On Refining and Processing Crude Platinum" at the annual meeting of the Learned Committee on Mining and Salt Industry of the Mining Society, held at the Mining Cadet Corps (now the Leningrad Mining Institute imeni G. V. Plekhanov).

The discovery made by P. G. Sobolevskiy, with the participation of his assistant, V. V. Lyubarskiy, was essentially that primary porous platinum sponge, placed in a metal mold, was transformed into a dense, solid product following compacting and subsequent sintering.

This marked the beginning of a new industrial process -- powder metallurgy. Coins, metals, tokens and other articles were made in Russia on the basis of this process, and later refractory metals were processed, articles from which were easier to obtain by compacting and sintering powders than by casting. Powder metallurgy found application in producing hard alloys and tools, porous, antifriction, magnetic, electrocontact, and other special materials.

Many properties of powder metallurgy, however, have not yet been utilized. Scientists, representatives of industrial enterprises, design and engineering organizations, who have gathered in Leningrad from many cities throughout the country, will discuss problems of development of one of the most progressive subbranches of the modern metallurgical industry.

The 26th CPSU Congress gave new impetus to the development of powder metallurgy. An integral combined program for 1981-1985 and for the period up to 1990 was formulated pursuant to the decisions of this congress. Specific-purpose nationwide planning of scientific and technical activities is making it possible gradually to surmount interministerial obstacles, which have been and continue to be perhaps the main factor inhibiting the extensive adoption of this unquestionably advanced technology. Due to the fact that problems of raw materials, equipment, and development of production facilities were not being resolved on a combined basis, powder metallurgy was for a long period of time compelled to limit itself to the production of a comparatively narrow group of materials and articles, special purpose for the most part. As a result of implementation of the specific program, the industry will obtain an adequate quantity of powder and the requisite equipment for processing it. The foundation will be built for gradual transition to profitable, no-waste production of widely-used structural materials and articles.

In its research activities the USSR Academy of Sciences Institute of Metallurgy attaches particular importance to such an effective area of powder utilization as employment of powders for hardening coatings. Our scientists have demonstrated that considerable practical return is generated in a comparatively short period of time by proceeding in this direction, with small initial outlays. Consumption of a ton of powder for coatings saves 40-50 tons of alloy steel. We figure that the system of regional scientific centers for coatings which was established in this country has constituted an important and useful organizational measure.

Leningrad enterprises are also making a substantial contribution to the extensive utilization of the invention which was born in their city. Much is being done in this area at the Leningrad Tool Association, LOMO [expansion unknown], the Association imeni Karl Marx, Elektrosila, enterprises of the radio and electronics industry, plus others.

A leading role in developing a modern raw materials base for powder metallurgy and industrial processes based on powder metallurgy is being played by such branch institutes and organizations as Mekhanobr, the All-Union Institute of Aluminum and Magnesium, Gipronikel', and others. Considerable initiative has been displayed and a genuine contribution has been made by scientists at Leningrad Polytechnic Institute, the Mining, Technological, and Mechanical institutes in development and coordination of scientific research being conducted in the Northwestern Region, and in training scientists and engineers for powder metallurgy.

Of exceptional importance for Soviet powder metallurgy is the rehabilitation of the Instrument Plant, which is commencing in the 11th Five-Year Plan at the initiative of the Economic and Social Development Council under the CPSU oblast committee. This plant is being set up for large-tonnage production of tools made of high-speed steel powders. One of the central problems of modern technology of metals is also being solved here, jointly with other organizations -- utilization and processing of waste chips.

Employment of powder metallurgy produces metal savings both in machine building, by reducing losses in chips during parts machining, and in metallurgy, in obtaining and processing powder-produced preforms, when the need to cut off flaw-containing ingot ends virtually disappears, etc. The smaller the size and the greater the number of parts being produced, the more profitable it is to use powder metallurgy methods. A thousand tons of articles produced from powder costs 1.8 million rubles less than with traditional methods, while with nonferrous metals the savings figure is 2.2 million rubles.

Another area of savings is the processing of machine building and metallurgical waste into powder, from which new machine parts can be made. A third, and perhaps fundamentally the most important area is savings in short-supply and costly nonferrous metals and a number of grades of high-alloy steel.

Powder metallurgy is to play an appreciable role in carrying out the USSR Food Program which was adopted at the May (1982) CPSU Central Committee Plenum. Considerable possibilities have already been discovered. According to studies conducted by specialists at the Kirovskiy Zavod Association and by scientists at the Polytechnic Institute, at the very least a number of parts (weighing a total of hundreds of tons) in tractor manufacture can be made from powders. Essential, however, are energetic and prompt measures to establish the appropriate production and experimental-industrial facilities. This too is within the capabilities of Leningrad's machine builders and metallurgical workers.

We should make particular mention of measures aimed at development of the Soviet powder metallurgy raw materials base. We shall recall that in ancient times the best grades of Damascus steel were obtained from iron ore coming from specific deposits. In other words, a natural alloy iron was used, containing valuable addition agents, which reduced the size of the grain in the steel and at the same time increased its strength and plasticity, and sometimes its corrosion resistance as well.

In the last century and a half powder metallurgy has made great advances, in recent years becoming an important factor in technological advance. Experience in developing this industrial subbranch compels one to think again and again about the inexhaustible possibilities of utilizing science to intensify production. It is appropriate in connection with this to recall a statement by P. G. Sobolevskiy: "That which may at first glance seem insignificant today, tomorrow may serve as the point of departure for important discoveries."

The November (1982) CPSU Central Committeee Plenum pointed to the exceptional role of science and technological advance in improving Soviet production, in creating an efficient economy, and in raising our people's living standards. This means increasing the responsibility of scientists and specialists for speeding up scientific and technological advance and the immediate application of scientific advances in production. And the scientific conference which is convening today should furnish answers to many questions with which science is faced in connection with practical utilization in the nation's economy of a promising area of development of technology, and it should provide a synthesis of experience and know-how amassed in this area.

3024
CSO: 1842/77

UDC 539.4

COMPUTER SIMULATION OF COMPOSITE MATERIAL FRACTURE WITH PHYSICAL AND CHEMICAL COMPONENT INTERACTION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 12, Dec 82 (manuscript received 2 Nov 81) pp 73-79

OBCHINSKIY, A. S., ZABOLOTSKIY, A. A., BILSAGAYEV, N. K. and KOP'YEV, I. M., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences

[Abstract] A fractographic analysis is conducted of fractures in fiber reinforced composite materials at the microscopic and macroscopic level. Sequences of elementary events in fracture are determined and a computer is used to model the processes of fracture in order to predict the mechanical properties of the composite materials. The first state of the material corresponds to weak, insufficient interaction of the components. In the second state of the material the components interact optimally. The strength of the reinforcing fibers is nearly the same as their initial strength and a strong bond is formed at the interface between the components. The third state of the material corresponds to excessive interaction of the components: the strength of the fibers may be significantly lower than in the initial state, while the bonding of fibers with matrix is usually quite strong but may be weaker than in the second state. Analysis of this multistaged development of fracture processes results in the generation of a single model for the prediction of strength properties of fiber reinforced components. Mathematical analysis indicates that with insufficient interaction of the components the macroscopic fracture mechanism is avalanche growth of damages due to breakage of fibers and their separation from the matrix. Where the interaction is excessive, avalanche processes involving fracture of fiber and matrix develop. With the optimal relationship the stage of damage accumulation is lengthened due to "competition" of fracture micromechanisms. Figures 6; references 5: all Russian.
[59-6508]

UDC 669.295

MALO-TAGUL'SK DEPOSIT, SOURCE OF TITANIUM IN WESTERN SIBERIA

Moscow TSVETNYYE METALLY in Russian No 12, Dec 82, pp 94-96

SOLOV'YEV, V. I., REZNICHENKO, V. A. and TALMUD, N. I.

[Abstract] The Malo-Tagul'sk deposit contains ilmenite-titanomagnetite ores, with the relatively richer and poorer strata alternating. The beneficiation capacity of the various types of ores has been studied, showing the possibility of producing titanomagnetite concentrates containing 4.5 to 11.4% TiO_2, 60 to 68% Fe_{tot}, and 0.74 to 1.18% V_2O_5, and of ilmenite ores containing 41.7 to 45.7% TiO_2 and 35.7 to 38.1% Fe_{tot}. Metallurgical evaluation of these concentrates was performed by the methods normally used. Melting of a reduced charge made up of concentrates of each type in equal proportions in an electric furnace produced a steel intermediate product and titanium slag. Melting of the ilmenite concentrates produced a low carbon intermediate product which must be desulfurated outside the furnace before use, plus a high titanium anosovite-tagirovite type titanium slag (91% total TiO_2). The studies showed that the ores of the deposit can be used to produce concentrates suitable for processing in a two-stage system producing vanadium-containing metal and titanium slag. Figures 3; references 8: all Russian. [58-6508]

UDC 669.295

EFFECTIVENESS OF PRODUCTION OF TITANIUM SEMI-FINISHED GOODS AND IMPROVING THEIR QUALITY

Moscow TSVETNYYE METALLY in Russian No 12, Dec 82, pp 56-59

MAKRUSHIN, A. L., KAGANOVICH, I. N. and KATAYA, V. K.

[Abstract] The main areas of development in titanium alloy production are noted: decreasing labor consumption in all technological operations by introducing new processes and improving existing processes; decreasing metal consumption per unit of finished production; increasing stability of properties

and qualities; and elimination of unworkable alloys. The new technological decisions made in all production processes are briefly noted, including melting of ingots, heating, sheet rolling, forging, specialized rolling and selection of alloy compositions. Further improvement along these same lines is a matter of serious work at scientific research institutes and production plants. A significant improvement in product quality and production process effectiveness is anticipated during the 11th Five Year Plan.
[58-6508]

UDC 669.295.5:669.788

CRACK PROPAGATION IN TITANIUM ALLOYS IN HYDROGEN UNDER CONSTANT LOAD

Kiev FIZIKO-KHIMICHESKAYA MECHANIKA MATERIALOV in Russian Vol 18, No 6, Nov-Dec 82 (manuscript received 26 Aug 80) pp 33-39

FISHGOYT, A. V., FOLACHEV, B. A., Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy

[Abstract] The theory of hydrogen embrittlement caused by internal hydrogen is used to create a physically well founded model of crack propagation in titanium alloys in an atmosphere of hydrogen with constant load. The metal is considered to be in planar deformation. The tip of the crack is considered for simplicity to be rectangular in shape. Three equations are derived to describe the propagation of the crack (equations 13-15). Results produced by the equations agree satisfactorily with experimental data. Figures 4; references 18: 7 Russian, 11 Western.

UDC 669.295:621.762.222:621.926.34

POWDER PRODUCTION BY CRUSHING TITANIUM SPONGE WASTE

Moscow TSVETNYYE METALLY in Russian No 1, Jan 83 pp 54-55

PAVLOV, V. A., KOKORKIN, S. N., VOLCHOK, Zh. G.

[Abstract] The purpose of this work was to study and evaluate the properties of powders obtained by grinding titanium sponge water in a 0.7 m diameter ball mill, charge 60 kg. A protective bulk medium of common salt was used to prevent oxidation or burning of the metal. The optimal grinding time was found to be 12-15 hr. Powders produced by grinding low grade titanium sponge are recommended for the manufacture of parts which will operate under moderate loads in corrosive media. Figures 2; references 5: 3 Russian, 2 Western.
[79-6508]

UDC 621.791.052:620.18

INFLUENCE OF LOCAL HEATING DURING HOT STRAIGHTENING ON MECHANICAL PROPERTIES AND STRUCTURE OF TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 83 pp 30-33

ZAIKIN, V. M., candidate of technical sciences

[Abstract] Welding deformations in titanium alloy structures are eliminated by cold and hot methods. Hot straightening has significant shortcomings as presently practiced. The best heat source is an oxyacetylene flame. The maximum tensile stress must be created in the heated area without significantly changing material properties. This can be achieved by heating the metal to the optimal temperature. To establish optimality of the straightening conditions one must study their influence on the mechanical properties, structure, corrosion-fatigue strength and corrosion resistance of the alloys. Optimal hot straightening conditions allow the temperature of the black side of sheets being straightened to be maintained within 600-700°C, not requiring gas protection of heated areas. Figures 4; references 4: all Russian.
[97-6508]

UDC 669.295

MINIMIZATION OF TITANIUM SEPARATION PROCESS DURATION IN AN ENTERPRISE AUTOMATIC CONTROL SYSTEM

Moscow TSVETNYYE METALLY in Russian No 1, Jan 83 pp 51-54

KIRIN, Yu. P., CHEREPANOV, A. I., PROTASOV, Yu. A., OVERIN, B. A. and MUSHKOV, S. V.

[Abstract] The task was set of determining the minimum possible duration of each individual separation process such that the chlorine content in titanium sponge does not exceed the permissible limits. A flow chart is presented of an algorithm for minimizing titanium separation time. Separation is divided into three periods in which the temperature of the reaction mass differs and can be determined from the reaction vessel wall temperature. Power consumption is used to predict the duration of the separation and determine when separation is completed. A control system using the algorithm has been put in operation at the Berezinikovskiy titanium-magnesium combine, reducing the separation time and decreasing the consumption of electric power. The economic effect achieved is 80,000 rubles per year. Figures 4; references 7: all Russian.
[79-6508]

MECHANISM OF HYDROGENATION OF TITANIUM ALLOYS IN ELECTROCHEMICAL DIMENSIONAL WORKING

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 6 Apr 82) pp 12-16

KIKUSAR, A. I., SENINA, O. A., PETROV, Yu. N., and SHMANEV, V. A., Kishinev, Kuybyshev

[Abstract] The main hypothesis concerning the mechanism of hydrogenation of titanium alloys in electrochemical working has been that the source of hydrogenation is cathodic hydrogen liberated by the electrode tool. However, this hypothesis is contradicted by various data. If we assume that electrochemical reduction of the oxidizer occurs on the anodically activated surface of titanium, in the case of H_3O the first stage is the formation of adsorbed atomic hydrogen. The process is schematically outlined. If the charge transfer stage in this mechanism is retarded, reduction of hydroxonium should result in the formation of molecular hydrogen. This work experimentally determines both the rate of liberation of molecular hydrogen at the anoidic surface and the degree of hydrogenation of the surface layer when the anodic and cathodic spaces are separated. It is found that anodic dissolution of titanium is accompanied by reduction of the hydroxonium ion. The results indicate that complex improvement of workability of titanium alloys in chloride-nitrate mixtures is possible, involving both an increase in working speed, a decrease in hydrogenation and an increase in localization of dissolution. Figures 4; references 12: all Russian.
[82-6508]

UDC 669.295:620.193.5

VT14 ALLOY OXIDE FILM STRUCTURE AFTER HEATING IN AIR TO 850°C

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 6, Nov-Dec 82 (manuscript received 30 Jun 81) pp 13-16

MAKSIMOVICH, G. G., FEDIRKO, V. N., LIZUN, A. T., BUNIN, L. A., Institute of Physico-Mechanics imeni G. G. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] An attempt is made to estimate the influence of alloying elements on the structure of scale on VT14 alloy after treatment in air at 850°C, holding time 1, 5 ot 10 hours. A schematic structure of the scale formed on VT14 alloy is produced. One hour holding at 50°C creates a scale consisting primarily of TiO_2 rutile and Al_2O_3 oxide, the Al_2O_3 at the gas-scale division boundary. As holding time increases to 10 hours, TiO_2 oxide dominates in the structure of the scale with Al_2O_3 on the surface and uniform distribution of MoO_3 and V_2O_5 throughout the thickness of the oxide. Figures 2; references 9: 5 Russian, 4 Western.
[89-6508]

UDC 539.375.5:620.382

INFLUENCE OF DEFORMATION HISTORY AND LOAD CYCLE ASYMMETRY ON CYCLIC FRACTURE TOUGHNESS OF VT9 ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 82 (manuscript received 4 Dec 81) pp 3-6

TROSHCHENKO, V. T., KRASOVSKIY, A. Ya., SINYAVSKIY, D. P., BEGA, N. D. and IVAKHNENKO, V. V., Institute of Strength Problems, Ukrainian Academy of Sciences

[Abstract] In a continuation of a study of the effect of deformation history on the critical characteristics of cyclic fracture toughness of VT9 alloy, results are presented from investigations designed to study the relationship of cyclic durability, creep and fracture toughness characteristics as a function of load cycle asymmetry, and to determine the influence of the primary load factors on these cyclic characteristics. Tests were peroformed at room temperature with a frequency of tensile loading of 0.3 Hz with three values of load cycle asymmetry: 0, -0.5 and -1. Smooth cylindrical specimens of VT9 in the $\alpha+\beta$ state were studied. It is shown that in short cycle loading the process of unilateral accumulation of plastic deformations results in a decrease in critical cyclic fracture toughness. Alternating deformation does not change the critical cyclic fracture toughness regardless of amplitude. The asymmetry factor significantly influences both unidirectional accumulated plastic deformation and critical stress intensity factor in the low cycle fatigue area. Figures 5; references 6: 5 Russian, 1 Western.
[55-6508]

UDC 669.018.8

CORROSION PROPERTIES AND PROPERTIES OF TITANIUM ALLOYS DETERMINED FOR STEAM TURBINE BLADE OPERATING CONDITIONS

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 83 (manuscript received 6 Aug 81) pp 66-68

NIKITIN, V. I., KARPOVA, T. Ya., ADAMOVA, S. P. Leningrad

[Abstract] Results are described from studies of corrosion-mechanical strength and corrosion resistance of TS5, VT20, AT6, VT5 and VT5-1 titanium alloys tested under the operating conditions of the blades in large steam power turbines. All of the alloys tested have good corrosion resistance. None of them would be subject to corrosion-mechanical damage under normal operating conditions. However, under extremal conditions a corrosive environment could damage the materials. Exposure to concentrated chloride solutions which might form beneath the layer of oxide-salt deposits on the blades is such a condition. The best combination of properties is that of VT20 alloy, though TS5 alloy

also has good properties. The intensive corrosion cracking of titanium alloys in contact with solid sodium chloride at high temperature indicates that blade surface temperature should be limited to 200°C. Figures 2; references 4: 2 Russian, 2 Western.
[88-6508]

UDC 621.791.052:620.193

CORROSION RESISTANCE OF WELDED TITANIUM JOINTS IN ACID MEDIA

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 82, pp 31-32

KUZYUKOV, A. N., candidate of technical sciences, KUZYUKOVA, A. N., engineer, and LEVCHENKO, V. A., engineer, Severodonetsk Branch, Scientific Research Institute of Chemical Machine Building

[Abstract] Studies were performed in 10% sulfuric acid with 10 g/l titanium dioxide at 80°C, in 80% acetic acid with 0.5% iodine at 80°C, 75% orthophosphorus acid with 5% sodium chloride at 80°C and in a commercial autoclave solution for the production of orthonitroaniline by amonolysis of orthochlorobenzene with ammonium at a maximum pressure of 6 MPa, temperature 197°C. The specimens were made of VT1-0 titanium (130-mm diameter disks 10 mm thick with straight and circular seams). Studies of the welded joints showed that they have high resistance to acetic acid with iodine but corrode rapidly in sulfuric acid with titanium dioxide and in phosphoric acid with sodium chloride. An increase in the depth of corrosion is observed 10 mm from the seam. The influence of residual stresses on corrosion depth is significant at 3.5 to 5 mm from the seam. Figures 4; references 3: all Russian.
[63-6508]

UDC 621.791.754:620.18

GAS CONTENT AND PROPERTIES OF OT4 WELDED JOINTS WITH PULSED ARC WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 82, pp 10-11

SHALIMOV, Yu. A., candidate of technical sciences, PALASH, V. N., candidate of technical sciences, and LEVITSKAYA, A. D., engineer, L'vov Polytechnical Institute

[Abstract] A study is made of the gas content and properties of welded joints in OT4 alloy produced by pulsed arc welding. Evaluation criteria were the content of oxygen and hydrogen in the joints as well as crack resistance under static loading. The specimens were welded with an infusible electrode. Gas

analysis was performed by reducing melt in an atmosphere of nitrogen. Analysis of the results showed that with descreasing pulse length and increasing pause between pulses the hydrogen content in the seam decreases, increasing in the area around the seam. The static crack resistance of the metal around the seam is less than that of the base metal. More severe welding conditions produce lower crack resistance. Figure 1; references 4: all Russian.
[63-6508]

UDC 621.791.052:620.17:669.15:194.2:621.643

STEEL TOUGHNESS REQUIREMENTS FOR MAIN GAS PIPELINES CONTAINING LONGITUDINAL FRACTURE STOPPERS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 82 (manuscript received 22 Jul 82) pp 5-9

PATON, B. Ye., academician, TRUFYAKOV, V. I., corresponding member, Ukrainian Academy of Sciences, KIR'YAN, V. I., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] Pneumatic testing of pipe sections 1420 mm in diameter and 150 and 210 m in length with multilayer envelope fracture stoppers around them confirmed their effectiveness. The operation of these fracture stopper envelopes is explained. They are intended to prevent long viscous fractures from developing in the basic pipe material. Computer simulation has been used at the institute to obtain anlytic expressions considering the influence of residual stresses and establishing the functional variation between the movement of the side of a crack, its dimensions, the mechanical properties of the material and the level of working and residual stresses in the cylindrical shell. Problems relating to the weldability of the pipe steels are not discussed. Figures 4; references 7: 6 Russian, 1 Western.
[60-6508]

UDC 621.791.052:539.4

CRACK PROPAGATION RESISTANCE OF JOINTS IN TITANIUM PSEUDO-α ALLOYS OBTAINED BY ARGON ARC WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 83 pp 20-22

GONSEROVSKIY, F. G., candidate of technical sciences, "TsKTI imeni I. I. Polzunov", Scientific and Production Union, Leningrad

[Abstract] Results are presented from a study of the resistance to development of preliminarily initiated fatigue cracks in sheets of TS5 and VT20 alloys and their homogeneous joints made by manual argon arc welding with SPT2 welding

wire. Crack propagation resistance was determined using a static loading scheme with concentrated force in three point bending. Brittle fracture tendency was estimated by the energy criterion defining the crack development stage. The crack propagation resistance of the seam metal was found to be higher than that of the base metal. Increasing the oxygen content from 0.067 to 0.12% in the seam metal increases strength without significantly increasing the critical temperature, but crack propagation work is reduced by a factor of 1.4 to 2.2. High temperature heat treatment of titanium α alloys significantly increases crack propagation work in the seam metal. Figures 3; references 4: all Russian.
[97-6508]

UDC 621.791.052:539.56:669.295

SPECIFICS OF FRACTURE OF VT6 ALLOY WELDED JOINTS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 83 pp 19-20

GEL'MAN, A. A., candidate of technical sciences, KOPELIOVICH, B. A., candidate of technical sciences, KOROBOV, O. S., candidate of technical sciences, ANURE'YEV, K. D., engineer and KARSANOVA, L. G., engineer

[Abstract] During pressure welding without melting, joints with good mechanical properties are obtained, but impact toughness is reduced without optically visible defects. To determine the reason for this a study was made of the internal structure of fractures in welded and monolithic impact specimens of VT6 titanium alloy. Electron-fractographic analysis was performed, and histograms of the distribution of chords intersecting the boundaries of pits on the base lines were constructed. The results of the electron-microscope analysis showed that there were point micropores less than 1 μm in diameter present. These are apparently the seeds of the finely dispersed pits. As diffusion processes develop, optically visible defects are broken into these tiny pores, which can be observed only by the electron microscope. The impact toughness depends on the dimensions, distribution and fraction of planar accumulations of defects in the joint. Figures 4; references 4: all Russian.
[97-6508]

UDC 621.791.4:539.378.3:621.791.052:539.38

MEANS FOR DECREASING RESIDUAL DEFORMATION OF PARTS OF TITANIUM ALLOYS DURING DIFFUSION WELDING

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 83 pp 17-19

GRIGOR'YEVSKIY, V. I., candidate of technical sciences and KARAKOZOV, E. S., doctor of technical sciences

[Abstract] The purpose of this work was optimization of the process of diffusion welding relative to the residual plastic deformation of parts. Specimens of OT4 titanium alloy were welded at 750 to 1000°C. The testing of welded joints showed that their properties vary as a function of residual deformation. It is established that the formation of contact between roughly worked surfaces is determined only by the deformation of the parts joined regardless of the diffusion welding parameters used to achieve the deformation. Quantitative estimates of the growth of thermal deformation relief of surfaces show its role in the formation of joints by diffusion welding of titanium alloy parts with low deformation. Plastic deformation of the metal in the contact zone is the main mechanism which breaks up surface oxides during diffusion welding of titanium alloys. Figures 4; references 9: all Russian.
[97-6508]

UDC 621.791.44.052:539.38/.4.014

DEFORMATION AND STRESS STATES IN DISSIMILAR METAL JOINTS WITH DIFFUSION WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 82 (manuscript received 23 Apr 82, in final form 15 Jun 82) pp 13-17, 20

LARIKOV, L. N., doctor of technical sciences, BELYAKOVA, M. N., candidate of technical sciences, Institute of Metal Physics, Ukrainian Academy of Sciences, ZAMKOV, V. N., doctor of technical sciences, KIREYEV, L. S. and SABOKAR', V. K., engineers, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] A study is made of the influence of various deformation plans on the distribution of stress near a joint, the structure of the contact areas of the metal, and joint quality. Experiments were performed on welded joints in VT1-0 technical titanium with M1 copper, 08Kh13 stainless chrome steel and armco iron with copper. Metallographic analysis confirmed the 2-stage nature of deformation processes arising during welding of titanium with copper and chrome steel. Analysis indicates that welding of titanium with copper and chrome steel should be performed at temperatures which prevent the formation of intermetallides and pressures assuring stresses in the contact zone near the yield point of the harder metal at the welding temperature. The welding temperature must be high enough to assure dynamic relaxation of the more plastic metal. Figures 6; references 10: 9 Russian, 1 Western.
[60-6508]

UDC 621.791.052:620.18:669.715:66.085.5

POSSIBILITY OF ELIMINATING INTERMETALLIC INCLUSIONS IN THERMAL INFLUENCE ZONE OF WELDED ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 82 (manuscript received 8 Apr 82) pp 18-20

DROBYAZIN, V. N., candidate of technical sciences, PODZIREY, Yu. S., POLOVNEVA, S. P., SOLDATENKO, G. A., and POPOVICH, K. D., engineers, Institute of Nuclear Research, Ukrainian Academy of Sciences

[Abstract] A study is made of the possibility of using radiation treatment to eliminate intermetallic inclusions in the zone of thermal influence in aluminum alloys by radiation treatment. An M-30 microtron producing electrons at 14 MeV, beam power 150 W/cm^2, was used to irradiate the specimens, which were cooled by liquid nitrogen vapors to -186±10°C to decrease thermal diffusion. The irradiated zones in 1201 alloy at this temperature with a dose of $2 \cdot 10^{18}$ electrons per square centimeter were found to have redistributed alloying element atoms, which had shifted from intermetallic inclusions in the solid solution, thus improving the properties of the metal in this area. Figures 2; references 8: 5 Russian, 3 Western.
[60-6508]

UDC 621.791.753.9:538.569:669.295.001.86

ELECTROMAGNETIC MIXING IN TITANIUM ARC WELDING

Kiev AVTOMATICHESKAY SVARKA in Russian No 12, Dec 82 (manuscript received 28 Apr 82; in final form 8 Jun 82) pp 46-48

BLASHCHUK, V. Ye., candidate of technical sciences, ONOPRIYENKO, L. M., engineer, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, SHELENKOV, G. M., candidate of technical sciences, and TROYANOVSKIY, V. E., engineer, Machine Building Plant imeni M. V. Frunze

[Abstract] The purpose of this work was to study the usage characteristics of welded joints in rolled VT1-0 sheet titanium and OT4, Pt-3V and AT3 alloys in media containing hydrochloric and sulfuric acids and sodium chloride in solution. Metallographic analysis of the macrostructure and microstructure was used, as well as local mass spectral and x-ray structural analysis of the distribution of impurities and alloying elements through the seam and over the grain field. Mechanical testing was also performed. Installations for welding longitudinal and circular seams in metal pipe materials are shown. Welding with the devices using a controlled electromagnetic field has been used since 1975 to produce heat exchange apparatus, containers and apparatus for mixing devices. The technological process of welding titanium with electromagnetic mixing has proven to be quite reliable over this time.
[60-6508]

UDC 621.791.72:621.373.826.002.237:669.24.018.44

OPTIMIZING LASER WELDING OF HEAT RESISTANT NICKEL ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 83 (manuscript received 8 Apr 82; in final form 21 Jun 82) pp 48-50

GRIGOR'YANTS, A. G., doctor of technical sciences, MOROCHKO, V. P., candidate of technical sciences, FEDOROV, B. M., TOSHCHEV, A. M., engineers, Moscow

[Abstract] The purpose of this work was to study by mathematical modeling the significance of welding rate, beam power, and focusing during laser welding of KhN68VMTYuK alloy 1.5 mm thick. The method of multifactor experimental planning was used, with the variable factors being welding speed, beam power and distance of focal spot from welded part surface. Response functions included melted metal surface area, seam width on face side and seam width on back side. The model obtained agrees well with the theoretical data. Increase in the welding rate and P=const decreases the running beam energy and, consequently, the melted area. The greatest influence on cross sectional area of the welded metal and seam width is that of the speed, while the focusing has the greatest effect on width of the back side hump. The welding speed and beam power should be maximized, and the focus should be in the depth of the welded part. Figures 3; references 5: all Russian.
[81-6508]

UDC 621.791.753.5.01:536.2:669.15-194:51.001.57

COOLING DURING MULTIPLE-PASS WELDING WITH LOCAL HEATING OF VARIOUS SIZED PLATES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 83 (manuscript received 28 Apr 82; in final form 30 Jul 82) pp 13-15

KOZLOV, A. V., candidate of technical sciences, KOMISSARCHIK, G. A., engineer, FASTOVSKIY, V. M., candidate of technical sciences, Leningrad

[Abstract] The purpose of this work was to study the possibility of modeling of the temperature factor in multipass welding of actual large structures using smaller specimens. The work was performed in two directions: comparison of the temperature fields in specimens and actual structures and computer modeling of the local heating involved in multipass welding considering the finite width of the welded joint. Medium alloy structural steel 30, 40 and 48 mm thick was welded with 5 mm diameter wire under AN-42 flux, running energy 40 and 80 kJ/cm. The seam root was manually welded before mechanized welding. Chromel-copel thermocouples were applied to the back side of the seam and at 250 and 500 mm from the seam axis. The thermal cycle was recorded during second and subsequent passes starting with the same temperature distribution as was observed in the seam metal after the first or subsequent pass. Cooling of plates of the same thickness but different sizes is practically identical

in multipass welding if each previous layer is cooled to the same temperature or if the time intervals between application of layers are identical in all cases. With equal intervals between application of layers the need for accompanying heating is determined by the relationship between the interval and the duration of cooling of the metal of the first layer to the preheat temperature. Figures 2; references 6: all Russian.
[81-6508]

UDC 621.791.052.001.24:539.43

DETERMINING DURABILITY OF WELDED METAL STRUCTURES UNDER TWO-FREQUENCY LOADING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 83 pp 7-12

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[Abstract] There is not at present any known well-founded method for estimating durability of structures exposed to two-frequency loads, in which the basic low-frequency cycle is supplemented by higher frequency components of lower magnitude caused by various types of vibrations. It is suggested that durability in two frequency loading can be determined from fatigue curves related to a single loading frequency by a coefficient which depends on the ratio of amplitudes and frequencies of the two loads. Large scale models under various stresses were tested to confirm the invariance of the coefficient with variations of the basic factors influencing the fatigue strength of materials and joints and to produce an expression for determination of the coefficient. Flat specimens measuring 155 x 20 mm made of low carbon and chrome nickel steels were tested. With a fixed relationship between the frequencies a directly proportional dependence of the base-ten logarithm of the ratio of durabilities was observed with both two frequency and one frequency loading as a function of the ratio of high frequency and low frequency cycle components amplitudes. The ratio was found to be invarient to stress concentration, residual stress, temperature, cycle characteristics, fatigue test type, form and level of loading. Figures 8; references 17: 13 Russian, 4 Western.
[81-6508]

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ENGINEERING PROBLEMS OF ROBOTIZING WELDED STRUCTURE PRODUCTION

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 83 (manuscript received 1 Jun 82) pp 1-6

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[Abstract] Some of the engineering problems related to the introduction of robots to the production of welded structures are outlined, including: selection of welded structures to be manufactured by robots; determination of methods of relative movement of the welding tool and product; transportation of the product to and from the welding position; selection of a method and location for assembling of elements of the product for welding; group application of robots; integration of operations in robotizing the production of welded structures; adaptation of robots to specific conditions in welding shops and areas. The solution of these problems and the creation of the robots themselves require the concentration and coordination efforts of scientific research institutes, experimental design bureaus and enterprises in various branches of industry. One means of organizing the work would be to determine the leading, best prepared enterprises, at which robotized production facilities should be first set up. An interbranch engineering center of robotization should also be created, with the task of assisting branches and individual enterprises to select processes for robotization, develop changes to products, equipment and organization of production to make them suitable for robotizing, to select welding robots and configure robot systems, to develop plans for robotized working locations, and to put robotized shops on stream. Figures 2; references 8: 7 Russian, 1 Western.
[81-6508]

COOPERATION BETWEEN SCIENCE, INDUSTRY IN METALLURGY URGED

Kiev PRAVDA UKRAINY in Russian 14 Dec 82 p 2

[Article by UkSSR Academy of Science Academician V. Trefilov, vice-president of the UkSSR Academy of Sciences, director of the UkSSR Academy of Sciences Institute of Problems of Materials Science: "Tomorrow"]

> [Text] The most important task being accomplished by scientists in cooperation with industry include development and practical adoption of new metallic and other materials possessing preselected, frequently unique properties, development of advanced technologies for producing metal, processing it and manufacturing modern equipment.

"A demand on metallurgical workers which has existed for a long time -- to produce MORE [in boldface] metal -- has now been inexorably replaced by a different demand. Not so much more as BETTER [in boldface]," stated Victor Ivanovich. "In other words, questions pertaining to the QUALITY [in boldface] of metal have been advanced to the forefront -- and this is expressed in the decisions of the 26th CPSU Congress and the November (1982) CPSU Central Committee Plenum. Inseparably interwoven in this aggregate of problems are tasks pertaining to producing new materials, their processing and consumption, the development of low-waste and no-waste technologies which ensure economical consumption of energy, material, and labor resources."

Large and responsible tasks have been assigned to science in connection with this. They were stated and concretized with regard to our republic at the November (1982) Plenum of the Ukrainian Communist Party Central Committee. Science can successfully accomplish these tasks only with a substantial scientific research lead for future years both in the area of basic and applied research. And the UkSSR Academy of Sciences concerns itself with establishment of such a research lead, its continuous replenishment, as well as practical implementation in industry of the scientific and technical ideas contained within this stock of completed research on hand.

For example, basic research conducted by scientists at the Institute of Electric Welding, Institute of Problems of Casting, and Institute of Problems of Materials Science led to the development of new grades of high-strength steels intended for use in various branches of industry. In particular, these include

cold-resistant, high-strength steels, considerable interest in which has been shown by the USSR Ministry of Construction of Petroleum and Gas Industry Enterprises and the Ministry of Gas Industry, since such materials should substantially improve the reliability of trunk pipelines. They also include steels and alloys with special properties -- to handle various specific technical tasks -- which should not only support the development of highly-efficient equipment but also guarantee a reduction in the materials requirements of machinery and equipment....

Accomplishment of this combined task should be promoted by more intensive development of the "fourth process stage" (advanced methods of heat treatment of rolled metal, which substantially improve its strength and other properties), aggressive expansion of production and utilization of economical structural shapes with "minus" tolerances, extensive utilization of high-strength cast irons proposed by scientists of our Academy of Sciences in place of steel and nonferrous metal castings, as well as employment of various inorganic materials -- basalt fibers, rock castings, ceramics, etc. Composite materials are assuming increasing importance. An important role is played by advanced commercial powder metallurgy processes.

I should like to stress in particular that an improvement in the technical level both of ferrous and nonferrous metallurgy is inseparably linked with the development of metallurgical machine building. Serious attention in this area should be focused on development of new, more efficient metallurgical equipment, so that metallurgical workers can not only achieve plan-specified production indices but also obtain reserve production facilities at which it is possible and necessary to perform experimental-industrial "shakedown" of new processes and equipment -- those which will be needed tomorrow and beyond.

3024
CSO: 1842/64

UDC 66.046.51

ALLOYING HEAT RESISTANT NICKEL ALLOYS WITH DIRECTED CRYSTALLIZATION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 268, No 4, Feb 83 (manuscript received 14 Jul 82) pp 865-867

KISHKIN, S. T., academician, STROGANOV, G. B., LOGUNOV, A. V., GLEZER, G. M., MOROZOVA, G. I., MOROZOVA, S. G. and SOBOLEV, G. I.

[Abstract] Studies were performed with MAR-M200 alloy. The alloying elements were titanium and tungsten. Properties, structure and phase composition of melts were compared for equiaxial and directed crystallization. The phase composition was determined by x-ray structural and chemical quantitative phase analysis. The influence of alloying with titanium and tungsten on heat resistance in alloys with directed and equiaxial structure is explained as follows. The decrease in heat resistance with an increase in titanium content in directed crystallization alloys results from an increase in liquation processes and a decrease in the γ'_1 fraction in the interaxial space of the dendrites. Upon variable alloying with tungsten in directed crystallization alloys the liquation characteristics of the tungsten itself change. The content of γ_2 fraction increases slightly and tungsten in γ'_1 is not decreased. This results in an increase in durability with increasing tungsten content and a decrease in heat resistance growth rate starting at about 11% tungsten. Figures 2; references 2: both Russian.
[87-6508]

UDC 621.1

SHORT TERM STRENGTH OF BOROPLASTIC REINFORCED TUBULAR SPECIMENS AT ROOM AND CRYOGENIC TEMPERATURES

Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 82 (manuscript received 17 May 82) pp 56-59

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[Abstract] Cylindrical specimens of D16T alloy reinforced with boroplastic were constructed for tensile and compressive testing. Four types were compression tested, differing in length and geometric characteristics. The

tensile specimens had a circular notch in the gage section, though the cross section of boroplastic was constant. Testing was performed on an instron test machine at 77 and 293°K. The tubular specimens were found to have high strength and rigidity as well as high specific strength, the result of division of the fracture stress by the specific gravity. Thermal cycling of reinforced tubes for 50 cycles in the low temperature range had no significant influence on strength or rigidity. As the temperature dropped from 293 to 4,2°K, the strength of the rods increased significantly. Figures 5; references 3: all Russian.
[55-6508]

UDC 669-412+536.252.001.5

EFFECTIVENESS OF UTILIZATION OF LIQUID-METAL HEAT CARRIER IN CONTINUOUS CASTING AND VACUUM-ARC REMELTING UNITS

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR. SERIYA TEKHNICHESKIKH NAUK in Russian No 13, Issue 3, Oct 82 (manuscript received 31 Jul 78) pp 90-96

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[Abstract] The authors use numerical modeling of the hardening process for a continuous ingot in order to investigate the utility of a liquid-metal heat carrier to: 1) hasten ingot hardening by filling the gap that forms between the ingot and the wall of the copper crystallizer as the ingot cools (and shrinks) during continuous casting; 2) serve as a hydroseal by providing a good thermal contact between the ingot's surface and the crystallizer's cooled wall, thereby maintaining the vacuum in the remelting zone, during vacuum-arc remelting. After setting up a system of dimensionless equations to describe the temperature distribution in the liquid and solid phases and discussing the results of their calculations in considerable detail, they conclude that the use of such a heat carrier speeds up the crystallization rate for both processes and that in vacuum-arc remelting, heat removal is most effective when the metal bath is shallow. Figures 5; references 8: all Russian.
[70-11746]

INFLUENCE OF NITRIDING IN ELECTROLYTIC PLASMA ON FATIGUE STRENGTH OF 45 STEEL

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 82 (manuscript received 27 Jul 81) pp 43-45

BELKIN, P. N., MARDAREVICH, R. S., PASINKOVSKIY, Ye. A., FAKTOROVICH, A. A., Kishinev, L'vov

[Abstract] A study is presented of the influence of nitriding in an electrolytic plasma on endurance of type 45 steel. Specimens were nitrided on a laboratory installation in aqueous solutions consisting of 10% NH_4Cl plus 5% NH_4OH and 11% NH_4Cl plus 11% NH_4NO_3. The voltage across the bath was 130 V, specimen temperature 650°C and 160 V, 750°C, treatment time 3 minutes. The brief duration of the process, possibility of local treatment without protecting areas not to be hardened and the significant increase in fatigue strength achieved indicate the promise of the use of nitriding in electrolytic plasma to increase the endurance of steel machine parts exposed to alternating loads. Figures 1; references 5: all Russian.
[82-6508]

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